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PRESIDENT AND MRS. KRUGER AT THE DOOR OF THEIR HOUSE AT PRETORIA.

THE WAR IN THE TRANSVAAL.

A RUPTURE between England and the South African republic has occurred. It would be more accurate to say a rupture between England and South Africa, since the white population that has established itself forever in the southern part of Africa—not only in the Republic of Orange, but also in the English colonies of the Cape and Natal, is almost all of it making common cause with the Transvaal. Those Dutch, Germans, and French, and English even, who have, without any idea of returning, left their native country in order to become African citizens, are nearly all uniting with the Boers of the Transvaal in order to defend with them their country of adoption, Africa, against the common enemy, England.

As these lines appear in print, hostilities have already begun and the war opened in earnest—a long and bloody war of which the stakes are, on the

MAP OF THE SEAT OF WAR IN SOUTH AFRICA.

one hand, independence and liberty, and, on the other, the annexation of immense and rich territories.

After what has already been published upon the subject, no one needs to be informed that England's objective is the auriferous region called Rand, situated in the heart of the Transvaal, and the center of which is Johannesburg.

There are four roads that permit of access to Rand. The first, which is to the south, is the railway that extends from the Cape and Port Elizabeth to Johannesburg, and then beyond Pretoria, the capital of the Transvaal. This is the classic route for the traveler, but at present it is impracticable. The English could not think of following it, since it traverses, from north to south, the Orange Free State, which has allied itself with the South African republic.

The second route is to the west. A railway, wholly in English territory, starts from the Cape, passes through Cape Colony and Rhodesia, follows the west frontier of Orange and the Transvaal and runs through Kimberley and Mafeking, whence a road leads to Krugersdorf and Johannesburg. This is the road that Jameson and his band followed in 1895. The crushing of these invaders was not of good omen; and this time England is apparently not thinking of following this dangerous and very long route. But perhaps the belligerents will make a diversion in this region in order to occupy the adversary. It is for this reason that the English have a thousand men at Mafeking, and the Boers just as many at Lichtenburg, on the other side of the frontier. In like manner, the troops of the state of Orange are ready to attack Kimberley or to repulse an English attack coming from that city.

The third route that permits of access to Rand is the railway that starts from Lourenço-Marquez upon Delgoa Bay, traverses the Portuguese territory and the territory of the Transvaal through Komati-Poort. An attack by this route requires the complicity of Portugal or the taking possession of Delgoa Bay by the English. One of these two hypotheses is assuredly not improbable; and so the Boers have troops opposite Komati ready to do battle with the invader.

The fourth route is through the English colony of Natal, and is the one that the English have now adopted, as they did in the war of 1881.

A railway line starts from Durban, an excellent port and the largest city of Natal, passes through Pietermaritzburg, the capital of Natal, and reaches Ladysmith, where it separates into two sections, one of which extends westward to Harrismith in the Orange Free State and the other northward to Heidelberg and Johannesburg, in the Transvaal Republic.

The northwest frontier of Natal consists of a chain of mountains, the Drankenberg, which are lofty and steep and insurmountable, except through a few extremely narrow passes—those of Van Reenen, Tandjes, Mollers, and Bothas, upon the Orange frontier, and that of Laing's Neck upon the Transvaal frontier.

Laing's Neck is, so to speak, the door of the Transvaal, and a strong, narrow, and easily guarded one. It is a relatively easy ascent of the Drankenberg, which is dominated by Majouba Hill, at the summit of which the English were crushed by the Boers in 1881. The railway from Durban to Johannesburg traverses Laing's Neck through a tunnel, which it is very likely that one or the other of the belligerents will be led to blow up. The entrance to this tunnel upon the territory of Natal is at Charlestown, while the exit upon the territory of the Transvaal is at Volksrust.

It is around these two points that is now concentrated the bulk of the English and Boer forces.

As for the northeast frontier of Natal, that is formed by the Buffalo River, in which there are but few fording places, and those very dangerous ones.

It is in the triangle of which two of the sides are formed by the northwest and northeast frontiers of Natal, and of which the apex is Laing's Neck, that the British troops are massed. The Orange and Transvaal troops are massed upon the sides of this same triangle.

What are these forces approximately at the present time? The effective force of the English united at Ladysmith, Dundee, Newcastle and Charlestown is estimated at 15,000 men, at a maximum. Five thousand men are en route, and will not reach Durban before October 15.

As for the army corps of 35,000 men of which the mobilization is ordered in England, that is far from being ready to start. Against such forces, the Transvaal, in which every Boer is a soldier in time of war, is capable of opposing, by a single levy, nearly 50,000 men. The Orange Free State is capable of furnishing at least 10,000. The volunteers of the Cape and of Natal will swell the number of the adversaries of England; and it is, therefore, a total of more than 60,000 men—skilful marksmen, knowing the resources of the country and habituated to the climate, that the British will find in face of them.

It is true that the Transvaal has not yet mobilized the totality of its troops, while President Kruger, in his patriarchal mansion at Pretoria, in which his wife and he lead an extremely simple life, and as modest a one as possible, is absorbed in the care and responsibility of an office, that has been daily troubled for the last four years by the continual protestations of England. General Joubert, commander-in-chief of the army of the Transvaal, has assumed direction of the military operations.

The issue of the contest no one can foresee. If the Boers remain as valiant as they were in 1881, before the discovering of gold mines made riches known to them, England might not succeed in overcoming the resistance of "farmers" fighting for their liberty against a foreigner who wishes to seize their mines. Should such be the case, English power in South Africa would be done for. And doubtless we should see the formation of a confederacy—the United States of Africa—that had shaken off the oppressive yoke of England, as the United States of America did of old.

For the above particulars and engravings, we are indebted to L'Illustration.

THE HISTORY OF HYBRIDIZATION.

By Dr. MAXWELL MASTERS, F.R.S., President of the International Conference of Hybridization.

So far as the details of practical cultivation are concerned, we are not so much in advance of our forefathers. We have infinitely greater advantages, and we have made use of them, but if they had had them they would have done the same. We are able to bring to bear on our art not only the "resources of civilization" to a degree impossible to our predecessors, but we can avail ourselves also of the teachings of science, and endeavor to apply them for the benefit of practical gardening. We are mere infants in this matter at present, and we can only dimly perceive the enormous strides that gardening will make when more fully guided and directed by scientific investigations.

To appreciate the importance of cross breeding and hybridization, we have only to look round our gardens and our exhibition tents, or to scan the catalogues of our nurserymen. Selection has done and is doing much for the improvement of our plants, but it is cross breeding which has furnished us with the materials for selection.

A few years ago, by the expression "new plants," we meant plants newly introduced from other countries, but with the possible exception of orchids, the number of new plants of this description is now relatively few.

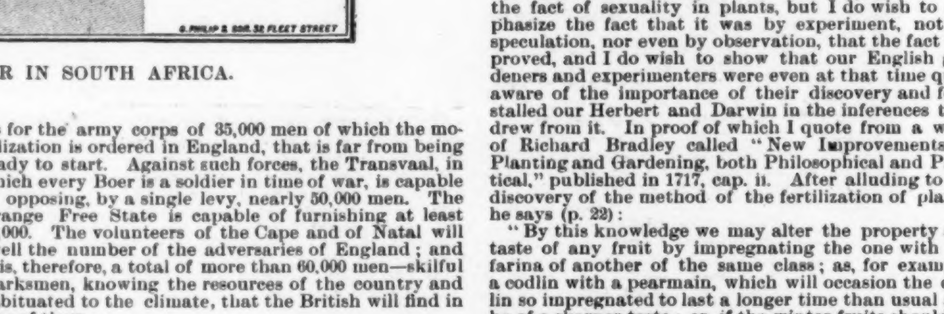
The "new plants" of the present day, like the roses, the chrysanthemums, the fuchsias, and so many others, are the products of the gardeners' skill. From peaches to potatoes, from peas to plums, from strawberries to savoys, the work of the cross breeder is seen improving the quality and quantity of our products, adapting them to different climates and conditions, hastening their production in spring, prolonging their duration in autumn.* Surely in these matters we have out-distanced our ancestors.

But let us not forget that they showed us the way. I do not propose to dilate on the share which Camerarius, Millington, Grew, Morland, and others, at the close of the seventeenth century had in definitely establishing the fact of sexuality in plants, but I do wish to emphasize the fact that it was by experiment, not by speculation, nor even by observation, that the fact was proved, and I do wish to show that our English gardeners and experimenters were even at that time quite aware of the importance of their discovery and forestalled our Herbert and Darwin in the inferences they drew from it. In proof of which I quote from a work of Richard Bradley called "New Improvements of Planting and Gardening, both Philosophical and Practical," published in 1717, cap. ii. After alluding to the discovery of the method of the fertilization of plants, he says (p. 22):

"By this knowledge we may alter the property and taste of any fruit by impregnating the one with the farina of another of the same class; as, for example, a codlin with a pearmain, which will occasion the codlin so impregnated to last a longer time than usual and be of a sharper taste; or, if the winter fruits should be fecundated with the dust of the summer kinds, they will decay before their usual time; and it is from this accidental coupling of the farina of one with the other that in an orchard where there is variety of apples, even the fruit which are gathered from the same tree differ in their flavor and times of ripening; and, moreover, the seeds of those apples so generated, being changed by that means from their natural qualities, will produce different kinds of fruit if they are sown.

"'Tis from this accidental coupling that proceeds the

* See some interesting observations of Macfarlane on the period of flowering in hybrid as intermediate between that of the parents, Gardeners' Chronicle, June 20, 1891, and on the structure of hybrids, May 3, 1890.



VIEW OF DURBAN (PORT NATAL).

numberless varieties of fruits and flowers which are raised every day from seed. . . .

"Moreover, a curious person may by this knowledge produce such rare kinds of plants as have not yet been heard of, by making choice of two plants for his purpose, as are near alike in their parts, but chiefly in their flowers or seed vessels; for example, the carnation and sweet william are in some respects alike, the farina of the one will impregnate the other, and the seed so enlivened will produce a plant differing from either, as may now be seen in the garden of Mr. Thomas Fairchild, of Hoxton, a plant neither sweet william nor carnation, but resembling both equally, which was raised from the seed of a carnation that had been impregnated by the farina of the sweet william."

Here we have the first record of an artificially produced hybrid, and this was more than forty years before Kolreuter began his elaborate series of experiments. Fairchild was the friend and associate of Philip Miller and of a small knot of "advanced" thinkers and workers who banded themselves together into a "Society of Gardeners."

"He is mentioned," says Johnson, in his "History of English Gardening," "throughout Bradley's works as a man of general information and fond of scientific research, and in them are given many of his experiments to demonstrate the sexuality of plants and their possession of a circulatory system. He was a commercial gardener at Hoxton, carrying on one of the largest trades as a nurseryman and florist that were then established. He was one of the largest English cultivators of a vineyard, of which he had one at Hoxton as late as 1722. He died in 1729, leaving funds for insuring the delivery of a sermon annually in the church of St. Leonard's, Shoreditch, on Whit Tuesday, 'On the Wonderful Works of God in the Creation; or, On the Certainty of the Resurrection of the Dead, Proved by the Certain Changes of the Animal and Vegetable Parts of the Creation.'"

Fairchild was thus not only the raiser of the first garden hybrid, but the originator of the flower services now popular in our churches.

We do not hear much of intentionally raised hybrids from this time till that of Linnæus, in 1759.* The great Swedish naturalist, having observed in his garden a tragopogon, apparently a hybrid between T. pratensis and T. parvifolius, set to work to ascertain whether this conjecture was correct. He placed pollen of T. parvifolius on to the stigmas of T. pratensis, obtained seed, and from this seed the hybrid was produced.

About the same time (that is, in 1760) Kolreuter began his elaborate experiments, but these were made with no practical aim, and thus for a time suffered unmerited oblivion.

Some years after Thomas Andrew Knight, and specially Dean Herbert, took up the work, with what splendid results is well known.

It is curious, however, to note that objections and prejudices arose from two sources. Many worthy people objected to the production of hybrids on the ground that it was an impious interference with the laws of Nature. To such an extent was this prejudice carried that a former firm of nurserymen at Tooting, celebrated in their day for the culture, among other things, of heaths, in order to avoid wounding sensitive susceptibilities, exhibited as new species introduced from the Cape of Good Hope, forms which had really been originated by cross breeding in their own nurseries.

The best answer to this prejudice was supplied by Dean Herbert, whose orthodoxy was beyond suspicion. He, like Linnæus before him, had observed the existence of natural hybrids, and set to work experimentally to prove the the justness of his opinion. He succeeded in raising, as Engleheart has done since, many hybrid narcissi, such as he had seen wild in the Pyrenees, by means of artificial cross breeding. If such forms exist in Nature, there can be no impropriety in producing them by the art of the gardener.

In our own time Richenbach, judging from appearances, described as natural hybrids numerous orchids. Veitch and others have confirmed the conjecture by producing by artificial fertilization the very same forms which the botanist described.

It remains only to allude to another respectable but

GENERAL JOUBERT.

mistaken prejudice that has existed against the extension of hybridization. I am sorry to say this has been on the part of the botanists. It is not, indeed, altogether surprising that the botanists should have objected to the inconvenience and confusion introduced into their systems of classification by the introduction of hybrids and mongrels, and that they should object to hybrid species, and much more to hybrid genera; but it would be very unscientific to prefer the interests of our systems to the extension of the truth.

The days when "species" were deemed sacrosanct, and "systems" were considered "natural" have passed, and Darwin, just as Herbert did in another way, has taught us to welcome hybridization as one means of ascertaining the true relationships of plants and the limitations of species and genera.

Darwin's researches and experiments on cross fertilization came as a revelation to many practical experimenters, and we recall with something akin to humiliation the fact that we had been for years exercising ourselves about the relative merits of "pin eyes" and "thrum eyes" in primroses without ever perceiving the vast significance of these apparently trifling details of structure.

I will not dilate upon the labors of Gaertner, of Godron, of Naudin, of Naegeli, of Millardet, of Lord Penzance, of Engleheart, and many others. Nor need I do more than make a passing reference to the wonderful morphological results obtained by the successive crossings and intercrossings of the tuberous begonias, changes so remarkable that a French botanist was even constrained to found a new genus, lemoinea, so widely have they deviated from the typical begonias. For scientific reasons, then, no less than for practical purposes, the study of cross breeding is most important. —Humanitarian.

* "Amœn. Acad." ed. Gillibert, vol. i, p. 212.

ST. JOHN LATERAN.

THE columns of porphyry and granite were so numerous at Rome that they ceased to have any value. At St. John Lateran, that church so famous from the councils of which it was the theater, there were such a quantity of marble columns that many of them were covered with plaster to be converted into pilasters, so completely had the multitude of riches rendered them indifferent. Some of these columns came from the tomb of Adrian, and bear yet upon their capitals the mark of the geese which saved the Roman people. These columns support the ornaments of Gothic churches, and some rich sculptures in the Arabesque order. The urn of Agrippa has received the ashes of a pope, for the dead themselves have yielded their place to other dead, and the tombs have changed tenants nearly as often as the mansions of the living. In the middle of the place before the church is an obelisk, perhaps the most ancient monument which exists in the world—an obelisk which the barbarian Cambyses respected so much as to stop for its beauty the conflagration of a city; an obelisk for which a king put in pledge the life of his only son. The Romans, in a surprising manner, got it conveyed from the depths of Egypt to Italy; they turned aside the course of the Nile to bring its waters so as to convey it to the sea. Even then that obelisk was covered with hieroglyphics whose secrets have been kept for so many ages, and which still withstand the researches of our most learned scholars. Possibly the Indians, the Egyptians, the antiquity of antiquity, might be revealed to us in these mysterious signs. The wonderful charm of Rome consists, not merely in the beauty of its monuments, but in the interest which they will awaken, and that species of charm increases daily with every fresh study.—The Architect.

Violle gave it as a result of his measurements that the spectrum of the acetylene flame differs only little from that of fused platinum. L. W. Hartmann has compared various mixtures of acetylene and hydrogen, burning in air, with the Hefner lamp. He finds that the candle power varies according to the completeness of the combustion, and is therefore influenced a good deal by the structure of the burner. A brass tip is unable to burn pure acetylene completely. The highest candle power is developed by a mixture of acetylene and hydrogen, containing 53 per cent. of acetylene. With a small lava tip the combustion is more complete, and maximum luminosity is obtained with 100 per cent. of acetylene. Acetylene burning in oxygen gives a very much higher efficiency. Phosphureted and sulphureted hydrogen and arsine are contained in commercial acetylene, and these have to be removed before it is safe to use it.—L. W. Hartmann, Phys. Review, September, 1899.

TUNNEL UPON THE RAILWAY LINE BETWEEN DURBAN AND JOHANNESBURG.

THE PARIS METROPOLITAN RAILWAY.

THAT section of the Paris city railway which is now under construction between the Bois de Boulogne and the gate of Vincennes will be underground throughout its entire extent except at one point—the station of the Place de la Bastille, where very peculiar conditions exist, the line having to cross the canal. It would certainly have been possible to cause the railroad to pass under the waterway, but, without taking into consideration the fact that such a combination would have necessitated the establishment of a very long stairway for the use of travelers, it would have involved the engineers in very peculiar difficulties. In fact, upon the general plan of the lines of Paris, it was seen that the north-south transverse line had to pass through the Place de la Bastille, and that, if the second passed beneath it, it would be located at a great depth beneath the surface should the first cross the canal through a tunnel.

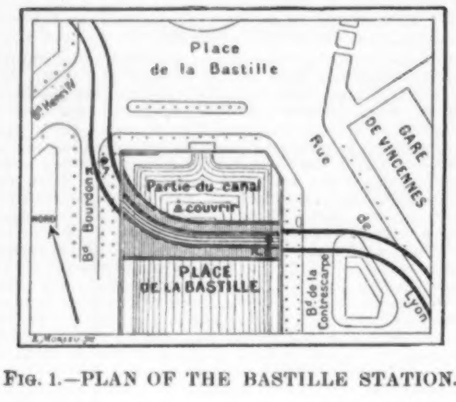


FIG. 1.—PLAN OF THE BASTILLE STATION.

It was, therefore, necessary to find a means that should permit of establishing a station upon the Place de la Bastille and of preserving the means of communication that already existed. The boat service could in nowise be interfered with; and, on the other hand, it was out of the question to think of constructing an elevated station, since this would have rendered the difficulties of access insurmountable and have necessitated the construction of a considerable amount of masonry and earthwork. The problem was reduced to establishing the station in the open air upon a bridge thrown across the canal and of diminishing as much as possible the height between the low water mark of the canal and the level of the rail. The solution arrived at is a most happy one, since it not only satisfies all the required conditions, but also increases the Place de la Bastille by 108 feet in width for the use of pedestrians.

The old towpath of the canal, as well as the canal itself, is filled in for the entire width comprised between the old and new quay walls. In this way there is reserved a covered passage of 65 feet that serves as a transition between the tunnel of the canal situated under the Place de la Bastille.

The Metropolitan runs underground to the Place de la Bastille through Rue de Rivoli and describes an arc of a circle of 160 feet radius in approaching the surface through a gradient of about three-twentieths of an inch to the foot. At the angle of Boulevards Henri IV. and Bourdon the work is sufficiently near the surface to be converted into a covered cutting (Fig. 1). The line forms a counter curve in order to reach the station, and is entirely in the open air starting from the curb of Boulevard Bourdon upon the canal. In this way it happens that the new station is situated 10 feet beneath the street level. It is established in a sort of open tunnel which, on the side of the Place de la Bastille, is formed of an ordinary sustaining wall, and, on the side of the canal, of a masonry wall 6½ feet in height, constructed in such a way as to prevent passengers from obtaining a direct view over the water.

The work to be executed was of two kinds. It was necessary on the one hand to establish upon the canal and its low sides the masonry necessary to form abutments, and, on the other, to construct a bridge of 65 feet span which should permit of the installation of the station and, at the same time, not interfere with the running of the boats.

The masonry is now finished (Fig. 2). In the first place, piles were driven so as to form two large inclosures of the same dimensions as the work to be executed, and these were then filled with concrete. As soon as the concrete reached the level of the adjacent low wharves, walls were constructed on vaults with tufa, according to the usual method, in reserving spaces for dressed stone pillars upon the outer facings. This portion of the work was the longest and the heaviest of all.

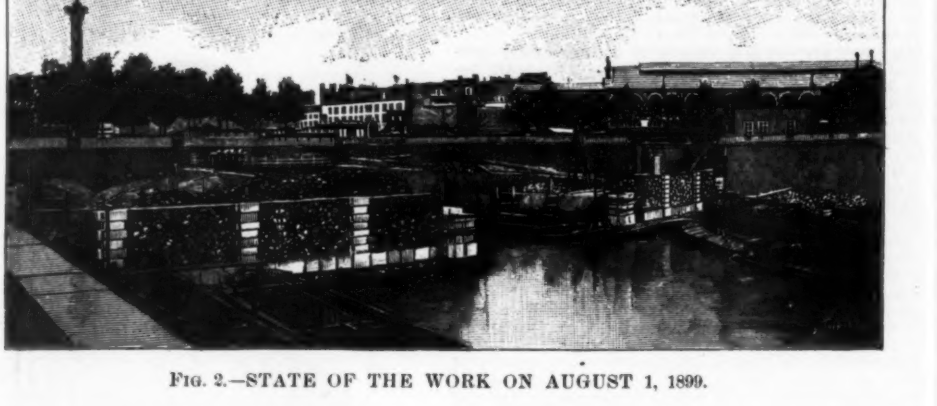


FIG. 2.—STATE OF THE WORK ON AUGUST 1, 1899.

The metallic part embraces a bridge 130 feet in width and of 65 feet span. There are two sections to be considered, that which is connected with the street and that which is to support the station properly so called. The first will be by far the more heavily loaded. In order to establish the calculations of resistance, the supposition was made that the girders would have to support as a fixed load the mass of earth that they have to sustain, and, as maximum movable loads, the city's road rollers, which weigh 30 tons. It is considered that these latter mark the weight of the heaviest vehicles running upon the street. Upon taking such figures as a starting point, it was found that the main girders of this part of the bridge would have to be 10 feet in height. As regards dimensions, they are comparable with the girders that support the superstructure of the Place de l'Europe.

FIG. 3.—TRANSVERSE SECTION OF THE STATION.

The trains of the Metropolitan railway will be relatively light, since they will consist of cars provided with electric motors, and they will obtain the current from works located outside of the line. Moreover, as the site of the station is lower, it was not necessary to have the same height for the girders under the rails as for the bridge under the roadway. Thirty two inches were calculated as being sufficient.

As before stated, an endeavor was made to lower the level of the rails as much as possible in order to diminish the height of the abutments and therefore the expense of filling. To this effect, the cross-braces of the large girders were established at the base of the latter. This method of operating even permitted of putting the main girders to profit for the construction of elevated sidewalks (Fig. 3).

The work that we have just described is being executed by the engineers of the city. As is well known, the city assumes all the expenses of the structure, which will reach nearly a million francs for the Bastille station alone.

The Metropolitan Company assumes charge of the undertaking. After completing the superstructure of the track, it is to execute all the work of arranging the stations. Upon the roadway of the Place de la Bastille it will construct a kiosk at about 60 feet from the head of the covered roadway that runs toward the Lyons station. This pavilion will be 19½ feet in width by 55¾ in length. A stairway will descend to the passenger platform of the up-track, while the down-track will be reached by means of a footbridge that will cross the tracks and end at stairways that descend to the platform (Fig. 4). A gallery opening at the bottom of these latter will give access to another stairway that will lead to the station of the north-south transverse line that is to be constructed, and the direction line of which will run at right angles with and beneath the Bastille line. This arrangement will permit travelers to make a connection without coming to the surface.

The city is a little behind in its part of the work, since it has not received the iron necessary for covering the canal; but the masonry is finished, and all that is necessary to set the work in operation is the arrival of the girders. The work of erecting is, as well known, always quickly performed; the difficulty is to begin. Despite this drawback, the engineers of the city hope to be able to deliver their part of the work over to the company during the month of November next, that is to say, at the date that had been fixed in advance. All the sections are to be finished at that date. The company will then be able to install the electric conduits and lay the tracks. It will have no time to lose in order to be ready for the month of July of next year.—For the above particulars and the engravings we are indebted to La Nature.

The great stumbling-block to the introduction of agricultural implements in the province of Angora, in Turkey, says a consular report, has been the apathy of the peasants themselves, who have a rooted disinclination to alter their methods in any way, and the not entirely unfounded objection that should the slightest accident occur to one of these implements it becomes immediately useless owing to the impossibility of effecting the necessary repairs.

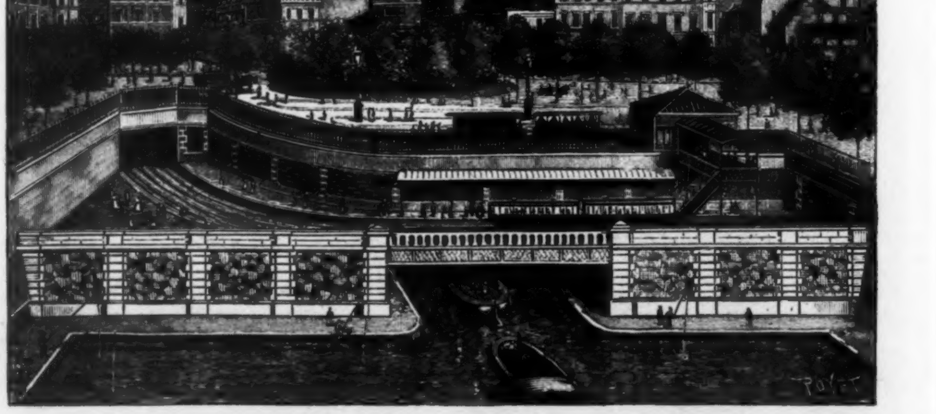


FIG. 4.—GENERAL VIEW OF THE STATION.

DUPLEX MILLING MACHINE.

WE publish herewith from The Engineer an illustration of a specially designed vertical duplex milling machine, recently completed by Messrs. Cunliffe and Croom, Limited, of Manchester, for one of the large shipbuilding firms, but which is also adaptable as a very useful tool for general engineering and locomotive works. This machine, the most noticeable feature of which is that it can be operated as either one tool for heavy, or as two separate tools for lighter work, is carried on a strong bed, of box pattern, 15 feet long, with four bearing surfaces to support the tables, which are each 10 feet long and 3 feet 6 inches wide. The space between the uprights is 8 feet, and the tables are each provided with variable self-acting feed motion in either direction, independently of each other, and a quick return by power in both directions. The tables and heads can be run separately as two machines, each with its own independent driving-feed, and reversing motions, or the tables can be coupled by means of an endless chain, which is easily detachable, and one or both can be put into independent operation. The uprights support a strong cross-slide carrying two double-geared headstocks, each provided with independent driving and feed motion horizontally, and also quick traverse for adjustment both horizontally and vertically by hand. A circular support is provided to receive and support the bottom end of each mandril, when the cutters are employed on side milling or profiling. All the motions for starting, stopping, reversing the feed, and putting into gear the quick return motion, are within easy reach of the attendant standing at either side of the machine in front of the upright, and close to the tool in operation. When it is desired to mill brass or gun-metal, or only required for light cuts in wrought iron or steel, the back gear can be thrown out of action. Two circular tables are provided, each 2 feet 6 inches diameter, one on each of the long tables, actuated by self-acting motions, when engaged on circular milling, such as round the ends of connecting-rods. These circular tables can readily be taken off the main tables when not required. The milling head stock spindles are of hardened steel, revolving in conical bearings adjustable for wear. A pump and cistern are provided with connections to keep a constant circulating supply of lubricating fluid on the cutters when working. The tool is of massive design throughout, and constructed to stand heavy cuts. All the gears are machine-cut from the solid.

BLOCKS DIRECT FROM DRAWINGS.*

OUTLINE OF THE PROCESS.—A zinc plate, coated with bichromated albumen, is exposed under the drawing, inked, and washed in water. A negative image is thus obtained, the lines of the original showing as bare metal. This image is then reversed as follows: The plate is coated with shellac varnish and soaked in turpentine. The ink image is thus cleared off, leaving the lines in varnish. The plate bearing the varnish image is then etched.

The original may be the original drawing by the artist, or printed matter of any description in books, catalogues, etc., or illustrations in the same, provided it fulfills the following conditions, viz.: 1. That the paper carrying the drawing, illustration, etc., is printed on one side only. 2. That the lines of the drawing and ink impression of the illustration are full or solid (see below). With regard to 2, if, on looking through the original, any of the lines are weak in ink they may be strengthened by going over them carefully with a pen, or brush charged with a good Indian ink. If desirable, additional work may be drawn in.

The original being ready, it is used in the same way as a negative, i. e., it is screwed in contact with the prepared metal plate, the drawing being next the metal.

PREPARING THE PLATE.—Polish the plate with emery powder, or by any of the approved methods, till water flows freely over it, and the plate shows no greasiness. Rinse well and flow with the following solution, without graining the plate:

1. Whites of eggs beaten to a froth and allowed to stand till clear.

2. Water (boiled and cooled)......... 6 ounces.
Ammonium bichromate........... 180 grains.
Alcohol.................... 9 drachms.
Liquor ammonia.... .... 6 "

Take equal parts of the clear albumen and No. 2, add a bulk of water equal to the mixture, and filter through cotton wool. After rinsing the plate, well flow with the foregoing solution and pour off the surplus; flow again and whirl. The speed and length of time to whirl can only be learned from experience, but it must not be too rapid. Continue the whirling over a stove (very slowly) till dry. See that the paper of original is not damp; if it is, dry it. Place the original in the printing frame, with the drawing face up. The frame may be an ordinary one if the springs are strong and give a fairly strong pressure. Place the prepared plate face down on the drawing and screw the two into contact.

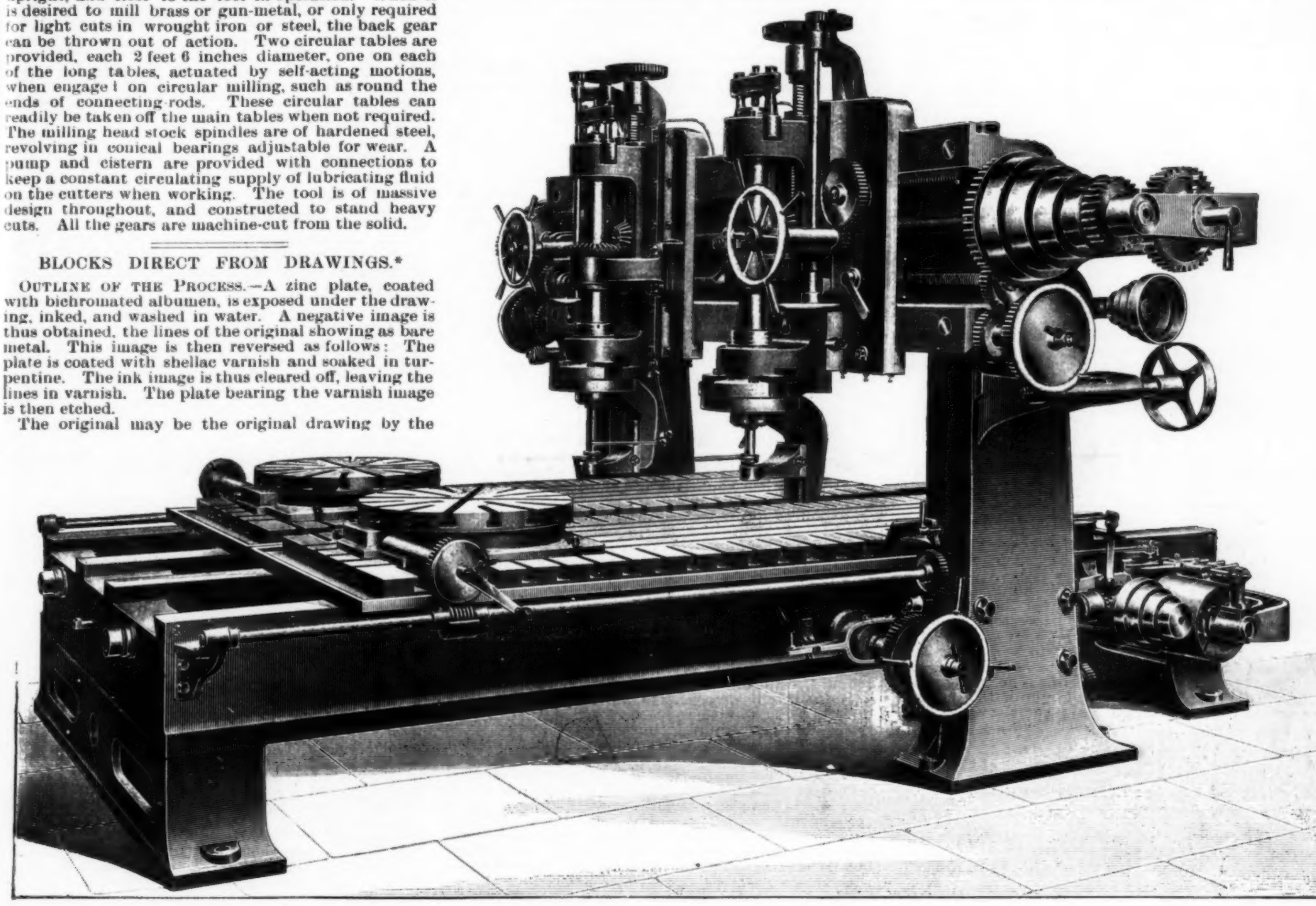
The exposure should be a minimum one if the ink of the drawing, etc., is weak, but there is some latitude if the ink is full. Using a Penrose actinometer and Ilford P.O.P. as the sensitive paper, for weak originals, No. 2 should just show; for good originals it may be carried the least bit farther. In every case a piece of the plain paper, cut from the original, should be placed over the actinometer—that is, between the sensitive paper and the source of light. The exposure complete, the plate is warmed and rolled up with transfer ink, thinned with spirits of turpentine to the consistency of cream. The coating must be even and thin enough for the metal to plainly show through. It is then developed in water with cotton wool and gives a negative image, the lines of the original showing as clear metal; every line must be cleared of ink. If the exposure has been too long and the finest lines will not clear, the plate must be cleaned and the exposure repeated, or the lines may be cleared with a piece of hard wood sharpened to an extremely fine point. This point may also be used to put in details that may have been overlooked in preparing the drawing. The plate being perfectly developed, it is rinsed, fanned dry, and put aside for a short time for the ink to dry in the air. Any additions or clearing up of the lines must be done after drying the plate. It is then ready for "fixing" the ink image. Dust the "fixing" powder over the plate with a soft brush, and brush off the surplus till the lines are clear of the powder. Now wash well under the tap, gently rubbing the plate with cotton wool to ensure the lines being perfectly clear. This done, dip the plate into water to which has been added sufficient ammonia liquor to make the smell perceptible, then rinse the plate and fan dry.

REVERSING THE IMAGE—Warm the plate now. It must not be made hot, but just comfortably warm to the hand. Then flow the plate with the special varnish. This operation cannot be performed in the same way as one would varnish a negative, since the surface is uneven, the ink image being in slight relief. For small work proceed thus. Place a funnel in an empty bottle (clean, of course), and, having warmed the plate, hold it over the funnel in a sloping direction and pour the varnish over it at the top edge with a sweep of the varnish bottle, so as to get an even flow over the whole plate downward. There must be no hesitation or stoppage in the pouring. As the surplus runs into the other bottle there is no need for anxiety on account of waste. The plate is immediately held over the stove and warmed to evaporate the spirit, and must be kept rocking to prevent streaks forming. When the plate is too large to flow as above, the varnish must be poured into a clean flat dish and the plate dropped into it, being picked up again immediately, rocked, drained, and warmed quickly. The warming at this stage must go further, and the plate be made as hot as the hand can bear. It is then placed at once in a dish containing turpentine (pure) and allowed to soak for a few minutes. The next operation is to clear off the ink image by brushing it away with the special bristle brush; a fair pressure may be used. As the brushing proceeds, the ink will clear away in flakes and will apparently leave the zinc clear. This is due to the varnish being so nearly the color of the metal. The lines, however, can be seen by looking at the plate, as it is held slanting away from the eyes. If the varnish is right, the ink will be easily cleared off. If the varnish is too thick, it will take a long time to clear away. Hence the important points are to have the varnish of the proper consistency and to get the coating even, both conditions being quite under the control of the operator. Then, again, do not be afraid to brush the plate, the lines consisting of hard shellac varnish will stand a fair amount of vigorous rubbing. When all the ink has been cleared off, rinse the plate well to remove the turpentine from it. Then place it in a bath of

Nitric acid.......... ....1 ounce
Alum ....2 "
Water... ....1 quart.

Keeping the dish, rocking the image will at once show up sharp and distinct, and it can easily be seen if all the lines are sharp and intact. If the lines are only very slightly broken they may be mended with a fine pen or brush and a good retouching ink. If the image is badly broken, it must be cleaned off with spirits of wine, and the operations repeated. Probably a few trials will be necessary before the operator gets au fait with the process. As already said the graining bath will show up the lines quite distinctly, they having a metallic luster on a gray matt ground. Supposing the image to have been successfully developed, we proceed to the etching which is carried out exactly as in the ordinary process. The varnish image may be looked upon as taking the place of the ordinary ink image which has been dusted with any of the powders in vogue for the "powder" process. The first etch may be carried just far enough to allow of rolling up with the glazed roller; then dust with resin. The remaining etchings may be carried out either by the "powder" process or the ordinary rolling up method. If the lines are close with no broad whites, the plate can be finished in one etch. This is easy with copper, but zinc is more difficult owing to the undercutting of fine lines by the acid.

GENERAL REMARKS.—The "process man" may, at first, be inclined to scout the notion of making a print on albumen from ordinary printed matter, he having been taught that for the ordinary negative absolutely opaque ground and clear lines are necessary; and he will naturally say that what is necessary in the one case will be equally so in the other. Without going so far as to contradict his theory regarding the qualities of the negative, let me say that, as regards this process, provided the lines of the print to be reproduced are not actually broken, i. e., leaving clear paper where there should be ink, a print on metal can be made as

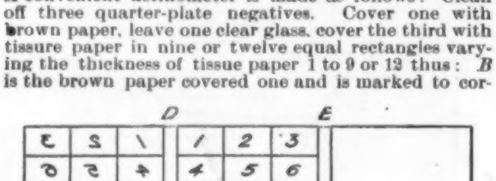


DUPLEX MILLING MACHINE.

* This process is patented in England by H. Hands, and is in practical use by him.

described. As long as there is an unbroken line, no matter how thin the ink deposited, it can be reproduced as described. There will, in every case, be a correct exposure which will do its work through the clear spaces of the paper and yet leave the weakest line developable. This will present no difficulty to the experienced "process man," and there is nothing in it that need frighten the beginner. It may be stated here that the fact of the first image printed on the metal being a negative one allows of slightly curtailed exposure when the lines are weak. Without taking up space with all the reasons, one will suffice, and that is, that there are a far less number of isolated fine lines which, with a minimum exposure, might wash away in development; broad masses of ink are less liable to do this. When the drawings are made specially for this process, care will, of course, be taken that the lines are unbroken and full. When printed matter is to be reproduced it must be examined by holding up to the light, and any broken lines mended or strengthened. A point to be noted is that when a line here and these prints through, it is an easy matter to clear away the ink with a fine pointed stick—much easier than is the mending of a line with ink. The other points to note are that the lines of clear metal, which are to form the ultimate image, must be clear of ink, dirt and scum; otherwise the varnish will not hold. Still another, the thinner the varnish is, consistent with forming an acid resist, the easier it will be to clear away the ink from the plate. The varnish, as sent out is right. When, by use, it becomes thicker it must be thinned with pure methylated spirits which is advisedly got with the varnish from the makers. If the varnish is kept to the proper strength by means of a hydrometer the working will be easier and certain results be assured. The "process man" will find the process easy and certain, while the beginner must in this as in all things persevere, carefully and accurately follow the instructions.

It is obvious that a plate as large as can be manipulated may have as many prints or drawings as it will carry laid down upon it, and the whole printed and etched together. When the paper of various originals varies, they should be classified, e. g., those on the thinner papers should be placed together at one end of the plate, thicker papers together in the middle and the thickest (or more strictly the densest) at the opposite end. Separate actinometers would then be used for each batch. The exposures would be made as directed above, that is, with a piece of the paper of the original over the actinometer. The exposures would of course, go on simultaneously, but the batch on the least dense paper would be finished first and would then be covered up; and so on, till all were complete. A convenient actinometer is made as follows: Clean off three quarter-plate negatives. Cover one with brown paper, leave one clear glass, cover the third with tissue paper in nine or twelve equal rectangles varying the thickness of tissue paper 1 to 9 or 12 thus: *B* is the brown paper covered one and is marked to cor-



respond with *A*, which has the tissue paper pasted on it. *C* is clear glass. They are hinged together at *D* and *E* with stout paper or thin leather. A piece of P.O.P. is placed on *B*, say on square No. 2. *C* is then turned down. Then on *C* and over the P.O.P. (or outside over *A*) put the piece of paper torn from the original, then turn down *A* and fasten with a letter clip during exposure. If the print to be reproduced is in a book and must not be removed, a special frame will be necessary and convenient. The actinometer will then be placed under the margin of the opposite page to obviate tearing off a piece of the paper from the book.—The Photogram.

[Continued from Supplement, No. 1242, page 19905.]

EVOLUTION OF TECHNICAL EDUCATION IN ECONOMICS, POLITICS, AND STATECRAFT,

AND THE WORK OF THE FRANKLIN INSTITUTE DURING SEVENTY-FIVE YEARS.*

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Times have thus strangely changed in these later centuries. In the middle ages and earlier, when all the world was composed of few masters and many men, when the great body of mankind was ruled and individuality was unknown among nations, even education was directed by the masters of men, and church and state were alike phases of aristocracy. The curriculum was prescribed by monastic rule, and the so-called "four learned professions" were theology, ruled by the church; law, constructed and manipulated for the monarch; medicine, the refuge of younger sons of the rulers, and philosophy, the resort of wealthy and aristocratic idlers. Engineering, the first and last and always essential basis of civilization and of all true advancement in material wealth, the necessary accompaniment of advancement in learning and the promoter of the most vital, moral and spiritual elevation, was unrecognized by Greek, Roman and modern European alike during the centuries preceding the nineteenth. Great mechanics and engineers were deified in the days of mythology; but they were ignored and contemned throughout historic times until our own saw the beginning of a real renaissance of the aristocracy of ideas, of true knowledge and of noblest powers of the mind of man. Individualism and the care of the state for the individual are the practical result of the progress of our own century.

The Declaration of Independence and provision for the protection of the inventor are corner stones in the foundation of the modern and current political creed and the firm basis of this latest and only true development of the people. It is only when each elementary atom of a population is developed to its highest and best in knowledge, intelligence, independence and character, that the great mass, the nation itself, becomes strongest and best. The specific gravity of the elementary molecule is that of the mightiest mass. Give the particles weight and value, and the mass assumes maximum value as a certain consequence. A hundred years ago the schools, the colleges, and the universities even of Great Britain, were inaccessible to the people of England; those of the continent of Europe were reserved, practically, to aristocracy. In the newly organized United States of America only, of all civilized countries, was education practically and legally free to all ranks and all classes. In these United States education was, from the first, recognized as the birthright of the people.

In the Massachusetts constitution of 1780 it was written:

"The encouragement of the arts and sciences and of all the literature tends to the honor of God, the advantage of the Christian religion, and the benefit of this and the other United States of America."

Wisdom and knowledge, as well as virtue, were recognized as essential to the prosperity of a nation, and the cultivation of the arts and sciences, as well as of literature, was made a duty of legislatures in order that the rights and liberties of the people should be conserved.

The great Northwest Territory was controlled by a primary law, the famous ordinance of 1787, in which it was declared that "Schools and the means of education shall be forever encouraged, the perfection of the individual as the elementary atom of the state being the end sought." Later came the slow, but still advancing recognition of the necessities of the individual in the perfection of the school system and of the various forms of curriculum required in each grade and in each class of educational institutions. While it seems sometimes questionable whether, with our combinations of masters and of men, of corporations and of trusts, of classes and of masses, the individual is not being again deprived of that liberty and opportunity which seemed on the point of being fully insured him, it is to be noted that, in all these kaleidoscopic movements of the modern world, the individual still retains his right and his power to rise from stratum to stratum to pass from class to class, to rise or fall, or to swerve from old into new courses, just as readily and just as far as his desires and his natural powers impel and permit. "Liberty always and everywhere insists on the use of all legitimate materials at hand for the attainment of its purposes. Such materials are ability, education, foresight, invention, personal influence, and material resources."* Only individual liberty to move in any and every direction in which one's talents, tendencies, interests, proclivities lead, can give true progress to individual or to nation. Freedom to secure not simply an education, but just the sort of education that one's talents and inclinations or one's necessities may seem to call for, is one of the most vitally important of those rights which Magna Charta and the Declaration of Independence have assured to mankind.

The placing of schools of engineering besides those of law and of medicine, the rehabilitation of the profession as one of the learned, as perhaps the most learned of professions, and the general organization of courses of instruction in the arts and sciences—sciences applied as well as "pure," and the extension of the school and college systems over the realms of technical, trade and professional instruction and training, have been the most obvious and fruitful results of the liberty of the individual and the endeavors of our century to promote the interests of the individual citizen and through him the progress of the nation.

While it is perfectly true that the evolution of education, including those branches which we distinctively call technical, covers a period extending back to the beginning of civilization, if not of human life on this globe, it is none the less true that more has been accomplished during our own century, more during the period of seventy-five years in the history of which we have here and now such special interest, than during the centuries, milleniums, which preceded.

Three remarkable developments of the present century, all the outcome of great social processes of evolution in various departments of our later civilization, have compelled the attention of students of history and of sociology in these later days, illustrating the fact that all modern progress had been made by advances of continuously increasing importance. The rate of progression under the action of the mighty forces which have become so sensible, in these decades which have seen substantially all the grandest movements of humanity, like that of a stone falling under action of gravitation, has been in each of these directions an acceleration. These three most wonderful accelerations have been:

1. The progress of invention and of the mechanic arts.

2. The evolution of modern physical sciences.

3. The advancement of systematic methods of cultivation of the mind.

Progress in the mechanic arts and engineering, scientific discovery, and the construction of the sciences, and that form of intellectual training which we call education, have all constituted the most important characteristics of the progress of the century.

At the beginning of this century, the existing educational system had not taken form, and its most striking development, the education of a people for the life and work of a people, the supplementing of a purely—and most admirable and most desirable—gymnastic education by technical instruction and professional training in the industrial professions, had not become systematized. Especially is it the fact that the distinguishing characteristic of modern methods of educations, classic and scientific, technical and professional alike—the placing of the work of instruction, in every branch of the pantology of modern educations, in the hands of specialists and of experts, men fitted by special education, by peculiar experience, and by natural proclivities to communicate most of each special knowledge to the pupil—has only now, and even now not completely, come into the accepted platform and constitution of education.

A generation ago, even, the proposition that in education, as in all other departments of human activity, to insure success the work must be performed by the expert worker was not admitted, and it was not unusual to place in charge of a department, or at the head of a college even, a man having no technical familiarity with the methods of the practitioner, whether mathematician or astronomer, chemist or physicist, engineer or classicist.

Clergymen were given the place of the pedagogical expert; lawyers were heads of schools of engineering; classicists were made presidents of schools of science; and the idea of finding a man fitted by practical experience and natural talent for the position properly assignable to an expert professional was unrecognized in the general confusion attending the construction and operation of the educational system. To-day all this is changed. Clergymen control the schools of theology, lawyers take in hand the schools of law, and engineers are taking the management of the schools of engineering; and the latest and least recognized forms of professional school are coming to be known as those exacting most of their students and adopting most extensive and intensive curricula.*

A glance through the pages of history reveals the fundamental thought of the modern and so-called education in the spoken and written words of philosophers of all ages, and its practical embodiment in the school systems has been witnessed in some degree, at least, from the earliest historic times. The first great university, that which even now stands as, its time and surroundings being considered, the representative university of all time—that founded by the Ptolemies over two thousand years ago, included technical learning and professional training in its curriculum, notwithstanding the anti-utilitarian sentiment of the Greek people and their philosophers and nobles.

Astronomy and navigation, mechanics and engineering, mathematics and all then recognized applied sciences, were there taught to all students and disciples by the most learned men of the time. The transfer of the arts and sciences and of all learning from Greece to Egypt, and by the Saracens to Spain, and from Spain and the shores of Northern Africa to Europe, and through the centuries to our own times, has always been so effected as to maintain technical and professional schools as a part of the system of education of every state, and the organization of the schools at Bologna and at Salerno, in connection with the medical and legal professions illustrated, centuries ago, the idea of the modern professional school. The Greek and the Roman and the Saracen and the modern European educations all alike were more than simply gymnastic and "classical;" all included, more or less, in varying degree, at different periods, the technical and practical side of education.

It was not, however, until the seventeenth century that the necessity of special and precisely planned technical schools or departments of the university became recognized necessities in the minds of many men and applied sciences were seen to be the real and ultimate end of the pursuit of the knowledge of the pure sciences and that the gymnastic forms of education have an ulterior and vital purpose in the promotion of the welfare of the people. Plato had declared education to be the business of the state and the inference was inevitable that the state should provide that education most likely to advantage the people. Milton pleaded for a "complete and perfect" education that should "fit a man to perform justly, skillfully and magnanimously all the offices, both private and public, of peace and war." Bacon had the same thought and Comenius, his disciple, planned a real "university," to include in its faculty men of science learned in the applications of science in the arts as well as men learned in languages and literatures. The Marquis of Worcester, the inventor of one of the modern steam engines, the exponent for his time of the truly broad and university educated man, urged upon his monarch the organization of a system of technical schools for the purpose of promoting the highest interests of the nation; Descartes sought the same result in a similar manner in France and, in that century, while all the sciences were taking new forms and making new and extraordinary progress through the then new systems of scientific research, the perfection and completing of the educational systems was a prominent thought in the minds of many of the greatest men of the day. Descartes, in fact, proposed a sort of Franklin Institute in which should be provided lectureships and schools for the people, a people's technical university, if that term, thus applied by John Scott Russell, may be admitted, in which the systematic and scientific development of all the educations likely to help the people to prepare themselves for the sequel of their lives should be effected. The foundation of the French "Conservatoire des Arts et Metiers" by the great inventor and mechanic, Vaucanson, was probably the first important actual embodiment of the ideas which had been familiar to Plato, to Aristotle, to the Ptolemies and their successors in the realm of education in later times. Martin Luther was among these successors and he and the great German educators early adopted the views of the leaders of thought of the preceding centuries. Germany was the first nation to put in practice the thesis of Plato and to inaugurate, formally and with considerable extent and symmetry, the systems of modern technical education of the people for the life and work of the people—and magnificently, as we may now perceive, has that nation profited by such wisdom and practical statecraft. To-day, the German system of national education is the admiration of the world. It is now a half century since John Scott Russell made his first study of those schools of the people of which he wrote in 1869 so glowing a panegyric.† They have

* Delivered at the Anniversary Meeting of the Franklin Institute. National Export Exposition, Philadelphia, October 7, 1899.

* Irresistible Tendencies. President Charles Kendall Adams. Atlantic Monthly, September, 1899; p. 293.

* Educational Problems. Electrical Engineering as a Profession. (Reprinted from the New York Evening Post, September 16, 1898.)

† "Twenty years ago, professional duty took me to Germany for the first time. I cannot forget my impression at the sight of whole nations growing up in the full enjoyment of systematic, organized, I might almost say perfect, education. I had already become acquainted with some theories and forms of education. I had read Plato's description of the perfect training for a nation. I was familiar with elementary school teaching, and enjoyed the privileges of university education and the still higher education of the workshop. I was familiar with the systems of Bell and Lancaster, having had personal acquaintance with its authors, and had myself taken an active part in schools of art and mechanics' institutions; but I confess to have been profoundly astonished—I may say humiliated—at the sight of nations whose rulers had chosen to undertake the systematic education of their people, and of peoples who had chosen to bear the burdens and to make the sacrifices necessary to obtain it. I do not know to what men or class of men in Germany the forethought, organisation, and patriotism are to be attributed which made them lay aside personal ambition, political animosity, religious sectarianism, and state parsimony in order to unite all the classes of people in a unanimous effort to raise every rank in society to a

steadily improved and broadened their field from that day to this and are still improving and maintaining their lead over other nations in many ways; although, if we may accept the judgment of some of their own ablest educators and professional men, our own country has, during the present generation, in some respects, struck on in advance of them in some departments in methods and curricula. Trotzendorf, Sturm, Neander and Comenius, Spencer and Francke, Basedort and Pestalozzi and Hecker built foundations upon which arose a great system of useful and stimulating education of every class in the community and in such manner as should give to all the power of making the most and best of every God given faculty, physical, intellectual, and spiritual. This system revivified and regenerated the German nation much as, in these later days, the "land grant" legislation of our own country has inaugurated a new system and new views of the needs of the people and the duties of the state. It made evident the fact that, as Russell states the point, the education of the nation is to be divided into two distinct divisions, logically: the one that which "educates and matures the man, and which we call 'general education'"; the other that which "specially qualifies the citizen for fulfilling that narrow round of duties which the subdivisions of labor in civilized countries imposes on the individual as his special contribution to the commonwealth and which we may call special or technical." In Germany, Russell found, as you or I may find to-day, the most systematic and economical and fruitful, the most "complete and perfect," national organization for the special care of this second division of educational work that the world has yet seen.

When, in our own country, we secure the union of this German national system of administration and this complete distribution of the statesman's care over all classes, and in all localities, with our own peculiar and specially efficient system of union of the scientific with the practical, the combination of gymnastic teaching with scientific experimental methods of the laboratory, in all departments and in all technical and professional work, we shall have attained very nearly the ideal of Milton and of the great educators and the real statesmen of our own time. This must soon come. The course of modern progress in this department of national life has been practically one which has a history, as we have seen, dating back to the earliest days of Greek culture; but real progress, with acceleration of measurable degree, really began in the times of Milton and of Bacon, took on importance with the organization of the German national system of technical and professional education in connection with the older, gymnastic systems, and assumed visible importance at about the time of the incorporation of the great enterprise whose accomplishments we here and now celebrate. During this century, and particularly since the last generation took a hand in the work, progress has been steady and increasingly rapid. Another generation should see our own country provided with an educational system, perfect and complete, broad as the continent, deep as modern life, and rich and fruitful as the best thought of the wisest educators and greatest statesmen can make it.

Every State and every nation owes to its people the organization of a general system of education—not abstract and ideal, not fitted to the purposes of the well-to-do citizens solely, not planned from the point of view of the older academician or fitted into the ancient monastic scheme—a system adapted to the immediate and practical needs of a great body of civilized people endeavoring to live and work and to enjoy the privileges of modern civilization on an average income of between six and seven hundred dollars a year, for a family, in the settled portions of the country; when this is understood, the question finds easy solution—in words. The difficulties of securing the inauguration, in even our enlightened country, of such a system, in the face of long-standing prejudice of existing and established curricula of the ancient and cloisteral type, of indifference on the part of politicians filling places belonging to statesmen, of ignorance, on the part not only of the average citizen and voter, but even on the part of the intelligent men of the country, very few of whom have given time to investigation, or thought to this most important of economical subjects, are beyond estimate. These difficulties, however, are certain to be in time overcome; for their removal is essential to the progress of our country in its great career.

The classification may, perhaps, take some such form as this:*

(a) A common school system of general education providing the elementary studies of a good English education; perfecting the pupil in the arts of reading, writing, and arithmetic, at least, and with so much of the most essential primary work in language, geography, etc., as space can be found for, without reducing the vitally important work to inefficiency. This system should be adapted to the needs of all classes.

(b) A system of special adaptation of primary instruction to the needs of children who must become skilled artisans, and who cannot be kept in school by their parents longer than during the period of their growth to that size and age at which they can be made to assist in the support of the family. Such a system may, perhaps, prove to require special adaptation of text books to the purpose, in which text books the terms of the trades, and reading matter giving accounts of industrial processes, may be introduced.

(c) A system of trade schools in which general and special instruction may be given pupils preparing to enter the leading industries; in which schools the principles underlying the principal vocations of the locality are to be taught and the essential actual manipulations, of the trades are to be illustrated and taught by practical exercises until the pupil becomes expert.

Thus, the Germans have be-sprinkled all over their country schools of carpentry, blacksmithing, weaving, bleaching and dyeing, forestry, agriculture, etc.

These schools should be established in every city and town in the State.

(d) Polytechnic schools should be incorporated, formally and with system, into the great educational scheme of the State and of the country, in which higher work in the applied sciences and, usually, some trade or professional instruction should be offered students whose circumstances are such that they may be given an education extending toward the years of maturity and whose talents and inclinations lead them to select technical school work as introductory to their later practice of the industrial arts.

(e) Technical schools and colleges, professional schools within the colleges and universities, in which the highest professional instruction in the applied sciences and in the scientific basis of the profession, may be offered those who are permitted by rare good fortune to secure a good, a liberal, education while preparing for entrance into the professional school and upon their chosen line of life work.

(f) Such a bureaucratic system of supervision and conduct; presumably by the State, acting through experts in all branches of educational work, and all imbued with the Miltonian idea—such as will insure symmetry and efficiency, of the whole great structure of education of the people for the life and work of the people.

(g) In the United States, the work of the several States should, it would seem, be correlated by a great central, a national organization, a national university, presumably, in which and to which all lines should converge straight from the most elementary of the primary departments and schools, through the whole system of academic and technical secondary schools and State colleges and universities, and which should thus serve at once as a source of authority and of instructing talent of the loftiest character, providing men of genius and giving grandest educational advantages to all the lower grades; giving the level up to which the tide of culture may rise in attaining the highest possible altitude, and serving, further, as the ultimate goal of the great minds of the nation.

(h) National bureaus of education having enlarged powers, wider duties, and grander opportunities of engaging in the task of instituting and promoting systematic and general education, such as Milton would have approved, and serving as the great advisory and directing agents in the permanent task of maintaining and improving the symmetry and completeness of the whole national, State and local systems of general and special education.

Supplementing all these, and doing a work that cannot be performed by any system of public teaching in classes and schools, should be found in every city and town such institutions as this in Philadelphia, lending a hand to the ambitious and less fortunate members of the body politic who have been unable to secure the advantages of systematic instruction or who, having neglected opportunities of this sort in earlier life, later are awakened to the desirability of perfecting and completing an imperfect and incomplete education.

The grand developments in the direction of the education of the people for the life and work of the people, in these later times, have been:

1. The institutions of the system of common school education in the United States, a system unequaled even now elsewhere, giving to every citizen a preparation for a life worth living such as no people ever had before.

2. The organization, first in France, of great technical schools under the supervision of the government, in which the older professional methods of training are adopted in the preparation of youth for the professions of the constructive arts and engineering.

3. The establishment, by Germany, in more complete form, of a system of national schools, manual training trade and higher technical, such is represented, in type, by the great Prussian school at Charlottenburg, near Berlin.

4. The organization of special, isolated, usually privately endowed, polytechnic, and engineering schools, like those of the United States and Great Britain, and which are typified by our military and naval academies, the Troy Polytechnic Institute, the Massachusetts Institute of Technology, the Stevens Institute of Technology, and the Drexel Institute.

5. The development of State universities devoted, in fair proportion, to the instruction of students in technical departments and schools under the patronage and care of the State, somewhat after the manner of the common schools—a system which finds its highest development in the Middle and Western States in this country, and which form part of the whole educational system of the State. The existence of large and privately endowed colleges and universities in the Eastern States has prevented its equal development on this side the Alleghenies.

"What is wanted in our day is that complete and perfect representative of one great and all-embracing system which shall, for its time, do what was done by the grandest of all ancient institutions, the greatest of all the ancient 'wonders of the world,' in its day; offer to all comers opportunity to study and to pursue all the sciences, all the literatures and all the arts of the contemporary civilization. Ezra Cornell expressed the ideas of Plato and of Aristotle and of Milton and of John Scott Russell in a sentence: 'I would found an institution in which any person can find instruction in any study.'

"This Cornellian ambition, absurd as it may seem to the dull plodder in the ways of the mediæval educator and of the monastic regime, is precisely that of the German empire and of its constituent political elements of the earlier generations, certainly since the time of Luther.

"Once it is recognized as a great principle of politics and economics that the primary duty of the State—given a system of government which steadily maintains the law and preserves the peace—is to see that the people are taught to make themselves competent to make the most of life and of the marvelous opportunities which modern civilization presents to all men, the obvious universality of the scheme of public education and training 'for the sequel of the lives' of citizens is instantly recognized and its practicability in a reasonable sense as well; for the powers of the State are to be invoked to their utmost limits."*

(To be continued.)

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higher condition of personal excellence and usefulness, and, by diffusing equality of education, to extinguish the most grievous of class distinctions." Systematic Technical Education; John Scott Russell; London, 1869.

* This scheme was substantially constructed as here presented by the writer when, as member of the New Jersey Commission for Devising a Plan for Encouragement of Manufacturing Industries in that State and as secretary of the Commission, he prepared for the Commission such a scheme.

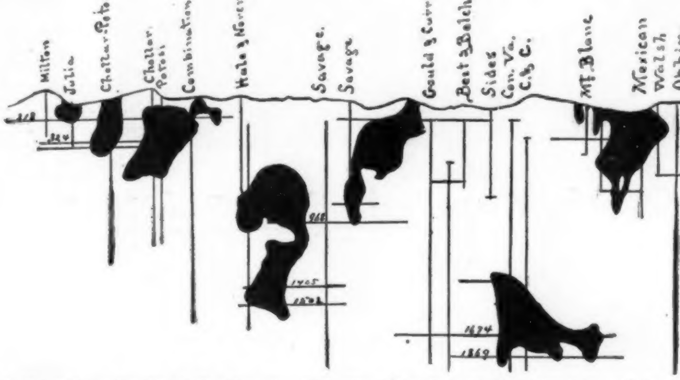
See report of New Jersey State Commission; Trenton, 1878; also Sibley Journal of Engineering, June, 1893, "The Demands of the State"; also the Trans. Am. Soc., M. E., 1892, vol. xiv, and Trans. Am. Soc. for Promotion of Engineering Education, 1898; "Organization of Engineering Courses," etc.

* On the Organization of Engineering Courses, etc.; Trans. Am. Soc. for Promotion of Engineering Education, R. H. T.; 1898.

THE COMSTOCK LODE.

By L. P. GRATACAP.

THE Comstock Lode remains an unrivaled deposit of gold and silver, and when we know that up to 1876, $235,000,000, had been extracted from its various pockets, we can appreciate the revived interest felt in its fortunes to-day. A gigantic scheme, in part successfully accomplished, has been conceived and applied for unwatering this great fissure. Filled with water which has prevented all work in the lower levels, it is now again, after almost twenty years of stagnation, attracting the attention of capital. The lode is now drained to 1,950 feet below the datum line on the surface, the work being done by the Risdon Company, of San Francisco, by a system of hydraulic elevators, operated on a suction principle, by water, and achieving on one occasion the unparalleled result of discharging 10,000,000 gallons in 24 hours.



Vertical Longitudinal Section in 1882, Showing Ore Bodies (dark), and Levels, in Tract, now being Unwatered on the Comstock Lode.

Repairs recently made upon the first elevator preparatory to sinking it below the second for a continuation of the work below the 1,950-level, have been completed.

The essentially difficult portion of the problem is now to be encountered, and every step is eagerly watched as the effort proceeds to remove water at a depth of over 2,000 feet.

Although described and studied in special geological treatises, and by surveys, few of the many who know something of the lode's history and its fame, know anything about its geological construction or those theories which are put forth to explain its formation. Richthofen, Ziekel, King, Church, Becker, Hague, and Iddings form a group of careful investigators who examined its features, while Lord has drawn and painted the sensational history of its development.

It lies in a part of that great basin of Utah and Nevada which has been the scene and center of extraordinary volcanic activity. It is thus described by Hague and Iddings: "Within this well defined area outbursts of lavas occur, forming high, rugged peaks, low, monotonous ridges interspersed with broad tables, extending for such long distances and covering such wide tracts of country as fairly to deserve the title of plateaus. Again, extravasated lavas may be seen as small isolated craters, as massive eruptions breaking out through lines of fissures and faults, and stretching out for miles along the base of the longitudinal ranges, or they may occur in small irregular hills, and occasionally in narrow dikes scattered over the country without any apparent law as to their distribution."

In this region against the eastern flank of Mount Davidson, a fissure crevice, initiated by a fault, has been formed at a time when the volcanic energy of the region had not yet subsided, and it has become the receptacle for the segregation of mineral matter charged with antimonial sulphurets carrying gold and silver. Confusion in determining the character of the rocks and errors of observation have been corrected by the last named writers.

They regard the main mountain mass as formed of pyroxene and hornblend andesites which, after a period of rest, have been penetrated by later eruptives. In the long continued seismic disturbances to which this

area was subjugated, especially in some of its later phases, when this Virginia Range, a spur of the Sierras, was elevated, this fault began, and became emphasized; and then ensued the periods of decomposition and filling. The east or hanging wall developed chambers or loosened sheets of altered rock, and the seam becoming a conduit for ascending vapors carrying chlorine or hydrofluosilicic acid as well probably as yielding a wide saturation with superheated water and steam, was a laboratory of metalliferous precipitation.

There is a feature in the Comstock Lode which reflects upon the explorations now in progress. Although a fissure vein it has not been filled in laterally and does not present the familiar condition of a central core—simple or bifurcating—of ore. The ore on the Comstock occurs in "bodies," bonanzas, pockets, chimneys, etc. These occupy spaces between the west and east walls formed by the crumpling of the latter, or its partial dislocation, accompanied by falling in of huge fragments. These bodies, rudely are lens-shaped masses usually of fine or sandy quartz carrying the ore. They occur at intervals along the length of the lode and also distributed through its vertical extent, separated by barren ground. Their location is quite undeterminable and their previous discovery has resulted only from search. It was, indeed, in 1869 that Dr. Rossiter Raymond, whose perspicuity in regard to the Comstock was really remarkable, wrote discouragingly that, "judging from present appearances only, and regardless of probable or possible new developments, I should say that remunerative operations on the Comstock proper can only continue for a period of eighteen months or two years longer." Yet, in two years from that time the "big bonanza" was opened on the 1,400-foot and worked to the 1,700-foot level. These zones of ore may occupy long strips, as the "Third Ore Body" of the early days of the lode, which commenced at the Gould and Curry claim and extended through the Savage, Hale, and Norcross, and Chollar, a distance of 2,700 feet. It was worked through a vertical distance of 650, 950, and 1,050 feet and went deeper. It was 60 feet wide in some places. These bodies may divide or separate into a number of seams. It must be recalled in considering these anomalous features that the Comstock Lode has, at least in its upper portions, an average width of 175 feet, that the filling of the vein has been intermittent, in all probability, and that such separated areas represent opportunities for deposition and concentration, in a wide fissure choked with "horses" and clay products of decomposition. These bonanzas are richest in the centers, and softer, with hard and low grade ore on the outside. At the center of the lode in the Bullion mine quartz filled the entire width of the vein from wall to wall, but was too poor for extraction. As a rule the ores decrease in richness from the surface downward. The "big bonanza" assayed $80 to the ton.

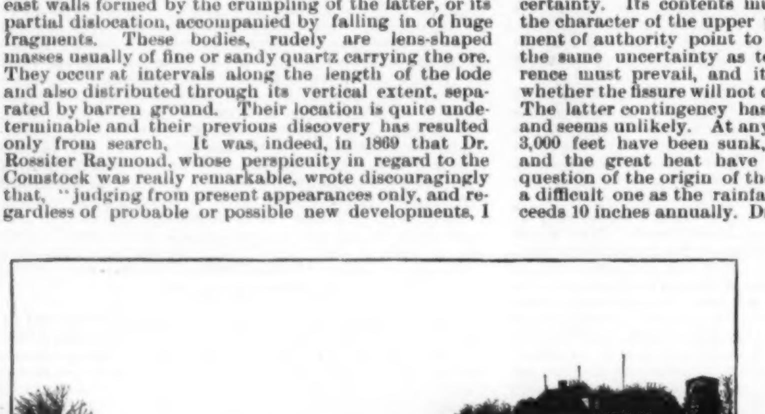
The immediate vehicles of transportation of the metals were fluorine and chlorine, assuming the ascension theory for this group of deposits. These gases form volatile combinations with the bases, and deposited their burden as oxides and chlorides, which later became sulphides and antimonides. This process was a long and probably irregular one; widening movements, disturbances, shiftings may have been attended with new accessions of vapors and mineralizing waters, while the decomposition of the east wall continuously contributed material toward packing the vein, and also enlarged it.

We seem to contemplate in this lode a draught way from deeply seated metalliferous areas, not as it has been mythically imagined, from regions of liquid gold and silver, but sections of the crust in chemical solution. The very hot waters of the lower levels (112° F.) show the proximity of a radient point of igneous intensity now quiescent. The continuation of the fissure is a certainty. Its contents must also partake largely of the character of the upper portions, though the agreement of authority point to lower grades of ore. But the same uncertainty as to their position and occurrence must prevail, and it is also impossible to say whether the fissure will not contract or seriously deflect. The latter contingency has never been contemplated and seems unlikely. At any rate shafts to the depth of 3,000 feet have been sunk, but the invasion of water and the great heat have stopped operations. The question of the origin of the great volumes of water is a difficult one as the rainfall of this region hardly exceeds 10 inches annually. Dr. Becker has furnished the violent hypothesis that the water of the lower levels of the Comstock, originates in the distant Sierras, from which through long underground drainage it finally reaches this fissure, and rises under a strong pressure, when liberated from its confinement by the pick or blast of the miner. The inundation of water was not more remarkable than its great heat—as high as 170° F.—which is a part of the thermal phenomena of the whole lode. The region has not, in its crustal depth, lost all the heat of its early volcanic energy.

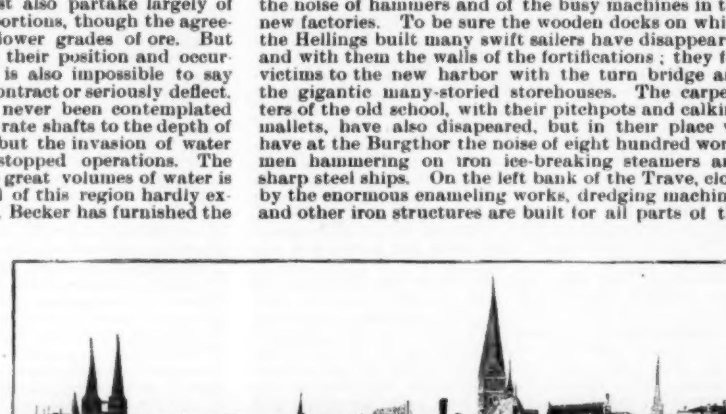
If the unwatering proceeds successfully, and mining at depth of 3,000 feet insues this terrific heat will be again encountered. It seems in this juncture that an intensive system of refrigeration could be inaugurated by means of liquid air. It certainly appears plausible to cool portions of the lowest levels by an expenditure of 30,000 gallons of liquid air daily, costing about $1,800, and generating some 3,000,000 cubic feet of air at a respirable temperature. As far back as 1877 there was forced through the lower levels 300,000 cubic feet of air in a minute, and yet life was insupportable in them. The application of liquid air may be quite chimerical, but it has a field for refrigeration in these depths, if again reached, of the Comstock, adequate to test its resources.

In the present remarkable undertaking this heat must be seriously reckoned with. Scientific expectation is awakened in this effort, as to the possible cooling by conduction through the rocks of the heat of the water, and a possible general lowering of temperature. To the many who are watching this new struggle to renew the prestige of the Comstock the caution can be properly repeated, that while doubtless there are ore bodies below, when, where, and how they are to be found is not predictable.

THE LÜBECK CANAL.



THE MÜHLENTHOR.



THE DRAINAGE SYSTEM BETWEEN THE MÜHLENTHOR AND THE HÜXTERTHOR.

HÜXTERTHOR BRIDGE.

THE BURGTHOR.

THE LÜBECK CANAL.

With prophetic eyes Emanual Geibel saw his beautiful native city awake from her long sleep to a new and busy life, and now the poet's dream is being realized, for in the tidy streets of the old emporium of trade on the Trave many men are busy moving bales and barrels to and from the great stores of the old patrician business houses, on many of which new names are now seen; and all around the city there is the noise of hammers and of the busy machines in the new factories. To be sure the wooden docks on which the Hellings built many swift sailers have disappeared and with them the walls of the fortifications; they fell victims to the new harbor with the turn bridge and the gigantic many-storied storehouses. The carpenters of the old school, with their pitchpots and calking mallets, have also disapeared, but in their place we have at the Burgthor the noise of eight hundred workmen hammering on iron ice-breaking steamers and sharp steel ships. On the left bank of the Trave, close by the enormous enameling works, dredging machines and other iron structures are built for all parts of the world, while farther down the river are extensive wood yards where tall firs from Russia and Finmark lie in piles awaiting shipment.

In order to open a cheaper channel into the interior for these products across the sea and to give the ships which bring them access to profitable cargoes for the return trip, little Lübeck has gone courageously to work to secure a new connection between the Trave and the Elbe, that is, between the Elbe and the Baltic Sea. Now the long cherished desire of former generations for an Elbe-Trave Canal has at last been attained, and the old Queen of the Baltic, as Geibel named the city, will lie on a new ostiary of the Elbe, which will open up to her an extensive district. It is not an easy matter for a community which numbers less than three-quarters of a hundred thousand souls, to carry out an enterprise requiring an expenditure of more than $5,-500,000. To be sure, her powerful neighbor, Russia, contributed a portion of this sum, but the little Hanse town furnished the lion's share, and she did it gladly, for this artery will bring her new life, causing her heart to beat faster and stronger than heretofore, in spite of the hard work entailed.

The building of this canal was a difficult matter, even for those who had gained much experience in their work on the Kaiser Wilhelm Canal. The course of a small river and the canal could not be disturbed, peat bogs and swamps had to be encountered, historic sights about Lübeck could not be molested, and when the

men began their excavations they found unexpected remains of walls and a series of palisades belonging to former fortifications which had been buried for hundreds of years. In spite of all the obstacles, however, the work went on briskly, and, although much still remains to be done, the main part has already been accomplished.

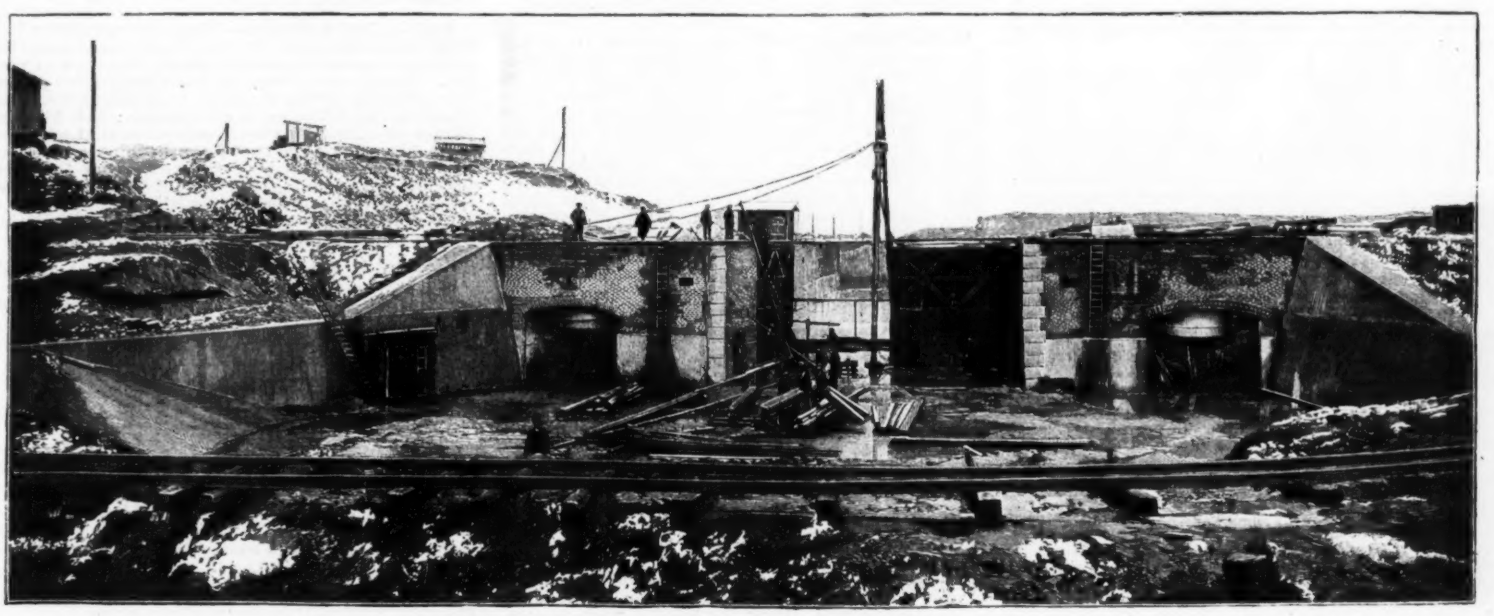
As early as the latter part of the fourteenth century, Lübeck built for herself, on a modest scale, a connection with the Elbe; we refer to the old Stekenitz canal which was the first artificial waterway in Germany, as we learn from the recent report of the Wasserbaudirektor, Mr. Rehder, who says of it: In spite of its limited dimensions the canal aroused the envy of its neighbor—this showed the importance they attached to it—and the men who built it had to work with a spade in one hand and a sword in the other; and they had to watch the completed portions to keep off the people of Lüneburg and later, of Mecklenburg and Stettin also; but, in spite of her bravery, the little city could not overcome all the difficulties to be encountered. The mouth of the Elbe, the entrance to the heart of Germany, was obstructed, and free passage into the territory of Lübeck was cut off by heavy chains. Taxes were illegally levied and maintained in spite of the complaints of the Emperor and the realm, and in spite of the voluntarily paid satisfaction money. These troubles lasted until comparatively recent times, and as late as May 13, 1843, the representative of Lübeck was able to show, at the Conference of the Elbe Navigation Commission in Dresden, that Hanover had exacted toll. When the waterway was at last made free it was no longer useful, because it was too shallow, too narrow and too crooked for modern purposes; and soon after this, forming the climax of all its troubles and its most dangerous rival, a railroad was built.

Since 1662 several plans have been proposed for the improvement of the old canal, but no decided steps were taken for many years. The new canal, is being built according to plans prepared by Mr. Rehder. It starts from the Elbe at Lauenburg, intersects the Berlin-Hamburg railroad near the Büchen station, passes Mölln, and strikes Lübeck on the southwest, follows highest part of the canal, which is 18½ miles long and is 40 feet above the Trave and 23 feet above the Elbe.

One of our engravings shows a lock in course of construction, and through one of the great gates we can see the open lock chamber, and we can also get a glimpse of the lifting bells and other devices incomprehensible to the uninitiated, by means of which the enormous lock chamber can be emptied or filled in ten minutes. All of these arrangements are now under water, and are operated by means of a lever in the hands of the keeper who stands in a little house that is visible over the open gate. The other end is closed by a floating gate that revolves on a horizontal axis. This gate is caused to rise by the admission of a few cubic feet of air, and when this air is exhausted it sinks into a recess in the sill of a lock.

Another engraving gives us a view of the drainage system between the Mühlenthor and the Hüxterthor, the enormous pipes, 1¼ yards in diameter, will carry the water from the outer Wakenitz under the canal to a new outlet when the old drain at the Burgthor is dammed up. The numerous piles and the shoring of the walls show how carefully everything must be strengthened that the work may be carried on successfully, in spite of the tremendous pressure of the marshy land and the ground water. A few yards farther on, a villa had to give way to the Hüxterthor Bridge and another will soon be removed. Here the canal joins the wide and formerly shallow Wakenitz, the outlet of Lake Ratzeburg, which was dammed up hundreds of years ago. It was necessary that its level should be lowered 9 feet in order that it might form the inner harbor, and it was therefore carefully dredged and the refuse was carried away without disturbing those who have residences in the neighborhood. Later two bodies of water having different levels, will flow along side by side.

The entire length of this water course is 42 miles, 16 miles of which is taken up by curves, none having a radius of less than 1,968 feet. In its shallowest parts the canal had a depth of 6 feet 6 inches, and its bottom is 72 feet wide, but arrangements have been made for increasing these dimensions at will to 8 feet, and 89 feet 6 inches respectively. Besides the harbors at Lübeck, Lauenburg, and Mölln, the canal is provided with several loading and unloading docks, turning out places, etc., so that immediately upon the completion of the work traffic can be carried on with the large vessels now used on the Elbe.—Ueber Land und Meer.



LOCK IN PROCESS OF CONSTRUCTION.

THE LÜBECK CANAL.

the old walls of the city on the south and east, and finally flows into the harbor on the north directly before the Burgthor. There was much opposition to this circuitous route, but it was considered the best for many reasons, chiefly because this arrangement would keep the large Elbe boats out of the small harbor as much as possible, and would also prevent their blocking the narrow Trave. The partial removal of the fortification with the fine promenade also caused a great agitation; it might also be said there was a struggle over every tree. At the Mühlenthor (Mill-Gate) a cut was made and much earth removed, thereby exposing to view the lower stories of the old Kaiserturm (Emperor's Tower) which had been hidden by the wall of the fortifications built three hundred years ago.

One of our views was taken near the Mühlenthor bridge, soon to be completed, and shows us a portion of a bed of the canal. Where this excavation has been made there was formerly a wall, 65½ feet high, which afforded a fine promenade shaded by elms nearly a hundred years old. The wall extended from the little cellar windows of the old school house above the recently reopened Kaiserthor, to the extreme left of our engraving. Around the city cement retaining walls have been built on both sides of the canal, the upper edges of which will be above the average waterline. The widened portion at the left of the engraving with the ornamental steps and balustrade will serve as a little harbor and anchorage for the steam launches and other boats that ply about the city. The dam shown in the engraving kept the river out of the excavation while operations were being carried on, but has since been removed. The Kaiserturm will not look just as it does in the engraving on account of the rebuilding of the upper part.

A portion of the canal is already completed and can be used as far as the Brüssau lock, which is in process of construction. The lock at the village of Crummesse is completed and in operation; and from it one may learn just what the other six will be. Five of these locks are required for raising boats from the level of the Trave, and two from the level of the Elbe, to the

JAPANESE AND CHINESE PAPER.

THE results of the inquiries of the commission of industrial experts, which was appointed by the German government to visit and report upon the markets of East Asia, show, according to a German trade review, that the various markets present excellent prospects for the paper trade, and the paper industry generally. The Corean hand-made papers, thus far very little known in foreign countries, are of much interest. They are of yellowish color, silk-like gloss, and extraordinary strength. In purity they are behind the better grades of Chinese papers. These papers are made in sheets of about 29½ by 51 inches. Oiled papers of this kind are used in place of window glass, and very impure but extremely strong board is also made of the same raw material, as well as blotting and wrapping papers. The Japanese hand-made papers are divided into two classes. The so-called "hansi" (half paper) is loaded with about 20 per cent. of rice starch; the "minogami" consists entirely of fiber. The Hanshi papers are the stronger and coarser, and are made in smaller sizes (about 9¾ by 13 inches), while the Minogami papers are thinner and better and larger (11 by 16 inches).

A quire of paper is called "jo" in Japanese, and has from 20 to 48 sheets; a ream is called "shime," and has from 480 to 2,400 sheets. The prices of hand-made paper have recently risen about 15 per cent., because the growers of bast demand and obtain higher prices for their product. Printing paper is used in Japan not only for printing purposes, but also for writing. The most popular sizes of printing paper are 25 by 27 inches and 31 by 43 inches flat. The consumption of paper has increased extraordinarily in Japan, and, although the home production is large, there is a good market for imported paper. Rice straw is an important factor in the manufacture of Japanese machine-made paper; only when there is a poor rice crop is wood fiber imported to any appreciable extent. Several Japanese paper mills, as well as the Fuji paper mill (the largest in Japan), produce their own wood pulp and wood fiber; the Ixono mill is said to be the only fiber mill which sells its products. Wood fiber is imported for the most part from Sweden, and brings, according to quality, from £16 to £24 per ton. In Skiroishi and in Atami, families make a paper textile in which the warp threads consist of silk or cotton yarn, while the woof thread are twisted from narrow strips of hand-made paper.

How much the production of hand-made paper increases, is demonstrated by the fact that in 1887 the total value of the production amounted to £940,000, while in 1895 it had risen to £1,820,000. The production of machine-made paper in Japan was in 1896 approximately as follows: Fuji, 12,000,000 pounds; Oji, 12,000,000; Kobe, 7,000,000; Senji, 6,000,000; Yakaichi, 3,000,000; Abe, 2,000,000; Yukosha, 800,000; Shimozato, 800,000; Ixono, 200,000; or a total of 43,800,000 pounds. The Muramatsu paper mills, near Shizuoka, produce excellent hand made paper, and especially noteworthy are the napkin tissue papers, unrivaled in silky gloss and beauty, which are also painted or printed with pictures, as well as the unsurpassed Japanese crape tissue paper. Among the most curious things to be seen in Japan, are the jackets and trousers of strong hand-made paper with which the Japanese soldiers were supplied during the war between Japan and China. The seams and button holes were sewn with cotton thread.

Chinese hand-made papers are made mostly of rice straw and are colored or stained on one side by hand, for instance, crimson for visiting cards (which are thin large octavo sheets), pale red for bills, yellow sprinkled with gold or green for wrapping goods, orange for wedding finery, etc. Large quantities are consumed in the principal place of its manufacture for decorating various places of worship which are visited by Chinese from all over the country, and considerable quantities are also sent to the adjoining provinces. There is no doubt that cheap imported machine-made printing papers, stained or unstained, could successfully compete with these home-made and hand-made papers, and the East Asiatic countries would certainly appear to present an attractive and lucrative field for the European exporter of paper.—Journal of the Society of Arts.

As there has been much speculation on the value of liquid air for blasting purposes, a brief account of some tests recently carried out in Vienna, Austria, to demonstrate the explosive properties of the liquid, will be of interest. The tests were conducted by the Vienna Crystal Ice Company, in the presence of a committee of the technical staff of the army. The liquid air was transported in open flasks and was not used until 72 hours after it had been manufactured, during which time half the liquid had evaporated and the proportion of oxygen contained had increased from 75 to 85 per cent. Holes 30 inches deep were drilled in the rock and charged with the liquid, which was then exploded, but without destructive effects. As a result of this test the experts in charge concluded that, to be effective, the liquid air must be used within 15 minutes of the time of preparation, which would seem to require that it must be made on the spot. It was admitted, however, that the use of liquid air for blasting, has, at best, only reached the experimental stage, and that improved methods of making and handling the cartridges might eventually be devised.

The first attempt at the spinning of cotton by the aid of hydraulic power was made in 1790 at the Falls of Pawtucket, Rhode Island, in the United States. In the following year William Pollard's newly-invented water spinning frame was erected near Philadelphia. In 1793 the "Old Slater Mill" was built at Pawtucket, and was the first successful cotton mill construction and operation in America.—The Engineer.

MISCELLANEOUS NOTES.

The British Consul at Moscow states that mill engines which ten years ago were supplied exclusively by Great Britain, are now bought largely from Switzerland. The Swiss engines are no cheaper than the British, but rather dearer, and the reason they are preferred is because the buyers assert that they are more economical in their consumption of steam, and show better finish than either British or German engines.

From the returns compiled by Lloyd's Register of Shipping it appears that, excluding warships, there were 558 vessels of 1,347,549 tons gross under construction in the United Kingdom, at the close of the quarter ended September 30th last. 533 ships of 1,342,385 gross tonnage were steamships, and twenty-five of 5,164 gross tons were sailing vessels. On the same date there were eighty-two warships of 412,980 tons displacement under construction, sixty-eight being in the hands of private firms, and fourteen in the Royal dockyards.

The author, in carrying out experiments on the action of hot water on glass, has succeeded in impregnating glass with water to such an extent that it becomes fusible below 200° C. The clear "water-glass" obtained in this manner swells up with loss of water when heated over a gas burner, and is converted into a white porous mass. The author states that glass as a colloid is miscible with water in all proportions; and that such solutions, if sufficiently concentrated, coagulate at ordinary temperatures, the congealed "aqueous glass" resembling ordinary glass in general appearance, and frequently melting below 200° C.—C. Barus, Amer. J. Science, 1898.

A town in Pennsylvania has an electric supply station, which, until recently, had been driven by a steam plant, the boilers being fired by natural gas. The boilers are now given up, and the gas is used directly in gas engines, three of 125-horse power, and one 200-horse power. The Westinghouse Company, which has supplied the engines, guarantees the consumption of gas not to exceed 13 cubic feet per brake horse power per hour, as compared with about 52 cubic feet on the former system. An air compressor, driven by a small gas engine, charges air reservoirs placed below the engine-room, which furnish the compressed air for starting the larger gas engines.

What is said to be the longest ocean pier of the kind in the world is at the Port Los Angeles, Cal., and is owned by the Southern Pacific Company. It was built in 1893 and is 4,382 feet long, and is 15 feet above extreme high water and 24 feet above extreme low water. It is constructed as a pile trestle, the material in the piles and bracing being creosoted Oregon pine and the balance of the material untreated Oregon pine. There are two curves in the alignment of the pier. Trains run to the extreme end of the wharf. According to The Railway Review, the chief commercial use of the wharf is in the trans-shipment of cargoes of coal and construction materials from the steamships of the Southern Pacific Company to the same company's cars, for use on its Southern California, Arizona, and New Mexico lines.

F. Giesel has examined a large number of radio active barium salts from de Haën's chemical factory. When crystallized fresh from the aqueous solution they gradually increase in activity. After some days or weeks they reach a maximum, and after that the activity remains constant as long as the crystals are kept free from moisture. Even concentrated solutions of the salts have some activity, but that gradually disappears. The crystals first crystallized are the most active. The author has not succeeded in isolating the active element, whether radium or polonium. But by precipitation with sulphureted hydrogen he has obtained a substance which exceeds the best barium salts in activity. The rays ascribed to polonium are more easily absorbed by metals than those ascribed to radium, and the former rays, therefore, yield better radiographs of the hand, etc., as they show more contrast. The author does not think that fractional crystallization alone will yield more highly active subtances.—F. Giesel, Wied. Ann., No. 9, 1899.

In Great Britain, 27,659 applications for patents were filed in 1898, as follows:

England and Wales	17,389
United States	2,629
Germany	2,599
Scotland	1,395
France	1,133
Ireland	502
Austria	414
Belgium	225
Canada	163
Switzerland	123
Victoria	121
Sweden	118
Russia	115
Italy	103

No other country furnished more than 100 applications.—La Propriete Industrielle.

The total wheat crop of 1899 is estimated by The American Agriculturist, in its final report, published to-day, at 565,350,000 bushels grown on 45,251,000 acres, as compared with a production last year which, in the light of the season's movement, cannot have been less than 715,000,000 bushels. The average yield per acre is placed at 12·5 bushels. The winter wheat crop is estimated at 297,000,000 bushels, with an average yield of 11·5 bushels per acre, while the spring wheat crop aggregated 269,000,000 bushels, with an average yield of 13·7 bushels. The average rate of yield of oats is returned at 30·4 bushels per acre, 2·5 bushels above that of last year and an average higher than was ever before reported for the whole breadth. The crop is estimated at 869,000,000 bushels, against 799,000,000 bushels in 1898 and 814,000,000 bushels in 1897. The quality of the present crop is reported as unusually good. The authority named places the average condition of corn 3 points lower than September 1, and only 2 points higher than was reported at this date a year ago, and adds that, if the final rate of yield shall substantiate that indicated by the present return, the crop is likely to be found rather above 2,125,000,000 bushels, a fairly liberal result, but not a record crop.

TRADE NOTES AND RECEIPTS.

Brown Shoe Polish. — Wieck's Illustrirte Gewerbe Zeitung gives the following receipt for brown shoes: Carefully melt together 15 parts of yellow wax and 12 parts of oil of turpentine. To the mixture, while still warm, add a hot solution of 12 parts of soap in 10 parts of water and stir the whole until cool. For color Nanking brown, previously dissolved in a little alcohol, is employed.

Cleaning Lamp Globes.—In order to remove from lamp globes the unsightly grease spots frequently met with and to restore the handsome matt appearance of polished glass, pour two spoonfuls of a slightly heated solution of potash into the globe, moisten the whole surface with it and rub the stains with a fine linen rag; rinse the globe with clean water and carefully dry it off with a fine soft cloth.—Neueste Erfindungen und Erfahrungen.

Production of Moth Tincture.—

Naphthaline	10
Carbolic acid	10
Camphor	5
Spirit	500
Lemon spirit	5
Thyme oil	2
Lavender oil	2
Sabina oil	2

—Neueste Erfindungen und Erfahrungen.

Genuine Gilding of Silk.—This can only be accomplished by the electric process. For this purpose the fiber is first rendered conductive by impregnation with silver nitrate solution and reduction of same with grape sugar and diluted alkali, or, best of all, with Raschig's reduction salt. In place of the silver nitrate, a solution of lead acetate or copper acetate may be employed. The silk thus impregnated is treated in the solution of an alkaline sulphide, e. g., sodium sulphide, ammonium sulphide, or else with hydrogen sulphide, thus producing a conductive coating of metallic sulphide. Upon this gold can be precipitated by electro-deposit in the usual way.—Leipziger Färber Zeitung.

Pasting Labels on Tin Vessels.—In order to obviate the loosening of paper labels on tin receptacles Apothecary Wilkening of Grossenbehringen, recommends to moisten the gummed labels with pure diluted hydrochloric acid (1 + 1) instead of water, and to paste them on at once. The vessel is then allowed to stand in the air for two days, so that the excess of acid not combined with the tin may evaporate. For pasting paper labels on varnished tin receptacles, as well as varnished wood and pasteboard, use hot glue to which about one-fourth of turpentine has been added. The turpentine partly dissolves the varnish and effects a firm adhesion of the labels to the vessels.—Pharmaceutische Zeitung.

Fire-proof Canvas for Tents.—

Water	100 liters.
Ammonium sulphate, chemically pure	14 kilos.
Boracic acid	1 "
Hartshorn salt	1 "
Borax	3 "
Glue water	2 "

Boil the water, put ammonium sulphate into a vat, pour a part of the boiling water on and then add the remaining materials in rotation. Next follow the rest of the hot water. The vat should be kept covered until the solution is complete.—Neueste Erfindungen und Erfahrungen.

Cleaning Pewter Articles.—The cleaning of articles of this metal is accomplished with hot lye of wood ashes and fine sand. Pour the hot lye upon the tin, throw on sand, and rub with a hard woolen rag; hat felt or whisk until all particles of dirt have been dissolved. To polish pewter plates it is well to have the turner make similar wooden forms fitting the plates, and to rub them clean this way. Next they are rinsed off with clean water and placed on a table with a clean linen cover on which they are left to dry without being touched, otherwise spots will appear. This scouring is not necessary so often if the pewter is rubbed off with wheat bran after use and cleaned perfectly. New pewter is polished with a paste of whiting and brandy, of which a little is used, rubbing the dishes with it until the mass becomes dry.—Metallarbeiter.

The Color of Gems.—The formation of the color of precious stones and other minerals is not easily explained in the majority of cases. The dye stuff contained in them may belong to an organic, as well as inorganic compound, but almost always its quantity is so small that it does not suffice for a chemical analysis. In the mineral, zircon, which is much used as a gem, especially under the name of hyacinth, the yellow, green, red or brown color can be ascribed to the presence of nitrogen, and the same thing has been proven for the well-known smoky quartz, which is very often erroneously called smoky topaz. The origin of the coloring of the amethyst has not been determined as yet, but the opinion that it was due to the presence of a compound of sulphocyanide with iron, has been found to be wrong. In many minerals the color is caused by the presence of chrome. This has been a long established fact as regards certain varities of garnet, spinel and diopside (a variety of augite). But other highly prized gems owe their color to chrome, e. g. the red and violet spinel, the ruby, the sapphire, the oriental amethyst, the green zircon and the topaz of Villarica, Brazil. In the ruby and the sapphire it is true, chrome could not be discovered direct, but it was established in the opposite way, that the combination of the elements constituting the said gems, and potassium bichromate produces colorless metals on the one hand but also red, blue, yellow and green ones. Thus, numerous other examples might be cited, in which the cause of the coloring of minerals might be ascertained, but a much larger number of colored minerals remains, whose color the chemists have not yet explained.—Tschermak's mineralog. u. petrographische Mittheilungen.

SELECTED FORMULÆ.

Soldering Flux.—The following is said to be a capital flux for soldering. Mix finely disintegrated resin with strong liquid ammonia, so as to form a sort of soap. This can be used with advantage for replacing spirits of salt, especially for soldering electrical conductors, the residuum of resin remaining after the operation forming a capital insulation.—La Revue Technique.

New Bath for Nickel Plating.—The Chemische Zeitung gives the following:

Nickel sulphate	1,000 parts.
Ammonium tartrate, neutral	750 "
Tannic acid	5 "
Boiling water	3,000 to 4,000 "

Dissolve the nickel sulphate in the boiling water and add the ammonium salt and acid, filter, and add sufficient water to make 20,000 parts. This bath is said to deposit nickel on any metal.

Cleaning Funnels and Measures.—Funnels and measures used for measuring varnishes, oils, etc., may be cleaned by soaking them in a strong solution of lye or pearlash (Pharmaceutical Era). Another mixture for the same purpose consists of pearlash with quicklime in aqueous solution. The measures are allowed to soak in the solution for a short time, when the resinous matter of the paint or varnish is easily removed. A thin coating of petroleum lubricating oils may be removed, it is said, by the use of naphtha or petroleum benzine.

A Waterproof Paper.—A French patent has been granted for waterproofing paper by the following process. Make a mixture of:

Olive oil, common	28 parts.
Rape seed oil	28 "
Linseed oil	28 "

To this add 8 parts of yellow beeswax, dissolved in 8 parts of oil of turpentine, by the aid of heat. Apply with a flat brush to either one or both sides of the paper, according to the uses to which the same is to be put. It is claimed that paper thus prepared remains waterproof longer than any hitherto brought into the market.—National Druggist.

Rapidly Drying Varnish.—Mix powdered resin with a thick milk of lime, set aside for twenty-four hours, then put over a waterbath, evaporate to dryness, and powder. This powder furnishes a basis for preparing durable and quick drying varnishes from the softer resins, of which the following is an example: Melt 100 parts of pine resin, and to the liquefied material add from 10 to 15 parts of the powder, a little at a time and under constant stirring. Continue the heat for thirty minutes, after adding the last of the powder, then remove from the fire and add from 25 to 50 parts of linseed oil and from 35 to 90 parts of oil of turpentine, according to the thickness desired.

Show-bottle Label Varnish.—An excellent varnish, which dries in a few seconds, and produces a colorless, smooth, and shining coat, is prepared, according to R. Kirsten, from the following:

Sandarac	53 parts.
Mastic	20 "
Camphor	1 "
Oil of lavender	8 "
Venice turpentine	4 "
Ether	6 "
Alcohol	40 "

The ingredients must be macerated for weeks, until a perfect solution is made. It is, therefore, advisable to prepare a sufficient quantity to last for some time.—National Druggist.

Combined Toning and Fixing Bath.—

1.	Sodium hyposulphite	1¼ pounds.
	Citric acid	½ ounce.
	Lead acetate	½ "
	Ammonium sulpho-cyanate	2 "
	Water	80 "

Dissolve in the water (warm) in the above order, filter bright, and add:

	Gold chloride	12 grains.
2.	Gold chloride	1 grain.
	Sodium phosphate	15 "
	Ammonium sulpho-cyanate	25 "
	Sodium hyposulphite	240 "
	Water	2 ounces.

Dissolve the chloride of gold in a small quantity of the water and add to the other ingredients dissolved in the remainder of the water.—Pharmaceutical Era.

Enamel for Metal Work on Bicycles.—This enamel is waterproof and wears well; it imitates closely the natural blue of steel, such as is on the "Cleveland" bicycle, and it can be removed with a rag soaked in alcohol at any time. It will keep indefinitely when tightly corked, and may be used on any metal. Here is the formula:

Bleached shellac	5 parts.
Borax	1 "
Alcohol	5 "
Water	4 "
Methylene blue	Sufficient.

Dissolve the borax in the water; the shellac in the alcohol (by maceration), reserving a small portion to dissolve the methylene blue. Heat the watery solution to boiling and add the alcoholic solution, stirring constantly; stir out any lumps and add the blue solution. Paint with a soft brush on the spokes, which have been cleaned bright with emery cloth. The quantity of blue needed is very small; by grading the amount employed any shade from a dark blue to a light steel color may be obtained.

Removing Petrolatum Stains from Clothing.—Petrolatum stains may be removed from clothing, it is claimed (Merck's Report), by means of the following solution:

Powdered soap	1 part.
Aniline	1 "
Water	10 "

The spots are moistened with the liquid, and after five to ten minutes washed with clean water. If necessary a second application is made.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

American Machinery in the United Kingdom.—Rufus Fleming, U. S. Consul, writing from Edinburgh, says: In reporting an interview which I had recently with an exceptionally intelligent engineer (machinist) in regard to American machinery and its use in the United Kingdom, I would say, by way of introduction as showing how well qualified he is to speak, that for upward of twenty-two years, including his five years' apprenticeship, he has worked at his trade in machine shops and factories in Scotland, England, and the United States. His varied experience has included work in many Scottish factories, and nearly four years as foreman in a well-known general machine shop in New York. He is at present chief engineer in a large factory in Lanarkshire.

At one time, he was employed in important locomotive works in England. On going to the United States, he first worked in the locomotive works of the New York Central and Hudson River Railway. He was here greatly surprised to see the rapidity of production compared with the rate of production in the same branch of industry in England. He said to me:

"The average employee was able to turn out fully as much work in a given time as his fellow-workman across the sea in Swindon. This remarkable result was accomplished largely through the use of improved machine and other tools. I afterward found much the same difference in the rate of production existing in many other branches of manufacture. This was a number of years ago. Meantime, and especially during the past two years, the proprietors of engine and machine works in this country have been, by foreign competition, awakened to the necessity of discarding some of their British machinery in favor of American labor-saving apparatus. The result is that few well organized works in the United Kingdom are now without a considerable proportion of such apparatus, and the proportion is constantly increasing. That it should thus increase is only natural, for this American machinery recommends itself at once. My present employers were induced to try American machinery only about a year ago. They now have five machines in use, while another of the same kind is at present on its way over from New York. I expect the amount of American machinery used by them will at least double within the next twelve months. The cause of their sudden conversion is not far to seek, and it furnishes a striking and convincing illustration of the value of American machinery. Before they began to use this machinery, the company had four British machines for preparing manila fiber for rope making. The combined daily output of these machines did not exceed 3½ tons. Each required two operatives. An American machine was introduced, costing $1,000—about the price of each of the British machines. It is worked by two operatives of the same class and receiving the same rate of wages as those who managed the British machines. It is capable of turning out five tons of the product per day if pushed, and it actually does turn out four tons each day. The product from the American machine is of better quality than that from the British. When this American machine demonstrated its superior utility, others were added to the plant from time to time."

To make sure that my informant was not mistaken in these statements as to the comparative efficiency of the American and British machines, I have verified them fully. However, that is by no means a rare example of the marked superiority of certain kinds of American machinery is indicated by the fact that on the same day, another engineer told me that he had just finished fitting up in a printing house in Edinburgh an American folding machine which is managed by one operative, and is hereafter to do the work that up to the present time has required four British machines, each with a separate operative. I have myself seen this American machine in operation. Its owners are greatly pleased with it, as it does its work in a far more satisfactory manner than any other machine they have for the same purpose.

The machinist first above referred to continued:

"Even the most conservative manufacturers in this country are now convinced, or are beginning to realize, that they can no longer afford to do without at least a moderate percentage of American general machinery, in addition to the common machine and other tools which have already been adopted everywhere. A great disqualification which much of the British machinery has in addition to its being slow to work with, is its unnecessary weight. It is often absurdly heavy. I may say, without reservation, that machinery of every description is invariably made lighter in the United States than in Great Britain. This is one reason why it so often gets preference over British machinery; its lightness makes it better adapted to general requirements. The American designers and makers seem to have a happy faculty of properly combining lightness with strength and durability in machinery of all kinds. One sometimes hears misinformed or prejudiced persons say that American machinery is 'jerry built.' This is the reverse of true, as the machinery not only does fine work, but is well built from the best materials. As to durability, it lasts as well as any in the world. A fiber machine which my employers got from the United States eleven months ago has, since its arrival, been worked continuously ten hours a day every week day except Saturday, and six hours on Saturday. It has never been for a moment in the slightest degree out of order and has never cost us a farthing in repairs, but has uniformly run without a hitch, and has at all times done its work faultlessly."

On the subject of rope and twine making machinery, with which he is especially familiar, he continued:

"American machinery of this class is far in advance of that made in other countries. It has already been adopted to a great extent by each of the more important works in the British Islands, notably by those at Belfast, where, in addition to several American drawing frames, there is a full assortment of other American machinery, comprising various sizes of the other three principal classes of machines used in the industry, viz., balling machines, twisters, and layers."

Speaking particularly of American machine and other tools, he said:

"The improvements in these tools and the beneficial results from their adoption in this country have been tremendous within the last three or four years. No machine shop can now be well equipped without tools from the United States—lathes, shaping machines, planing machines, screwing machines, etc. These, not to attempt to enumerate the hundred kinds of hand tools, are being used everywhere throughout the British Islands. You may say that no machine shop worth mentioning in this country is without at least such tools as turret lathes and ordinary lathes of American manufacture. The turret lathe, which is made in many sizes, varying in price from $250 to $1,000, is a typical example of the general convenience of American tools. With the ordinary British lathes, used for the same purposes, workmen lose time in substituting one tool for another which may not be readily found. The turret lathe obviates this delay. A full assortment of tools being fixed in its turret, the workmen can instantly get any tool by a slight turn of the turret.

"Certain British manufacturers are now turning out machine tools, etc., made exactly, or almost exactly, after American designs. A firm in Leeds make a specialty of constructing machine tools and some other labor-saving machinery according to American patterns. The company probably pays a considerable sum in royalties to American patentees."

With reference to the swelling volume of importations of American machinery, and the ultimate effect upon British industries of this new factor, he expressed opinions which may come as a surprise to those not closely in touch with the industrial forces of the day. What he said is here given:

"British manufacturers have been criticised for their conservatism, by none more sharply than by the leading British papers. Let me say that this conservatism has not been a matter of choice, but, as they have thought, an imperative necessity. They know—have long known—that American machinery and methods are beating them in their own markets. They have been known that for their own salvation they must adopt American machinery and methods but until quite recently, they took no step in that direction for fear of bringing on a serious complication with the working people. To rightly understand the problem which British manufacturers have to deal with, one must consider the differing industrial conditions in the United States and the United Kingdom. Leaving wholly out of view the different economic systems, what do we find in comparing the two countries from an industrial stand point? The wages of skilled labor in the States are from 70 to 90 per cent. higher than the wages of skilled labor here. Good wages inevitably mean greater efficiency of labor. Workmen are stimulated to put forth their best efforts. They work cheerfully, and, therefore, they work well. Moreover, the high scale of wages has been a strong influence in favor of the invention of machinery which gives labor a productive capacity corresponding to the wages received. If labor-saving machinery has thrown men out of employment in any branch of industry, they have quickly found work in another, so multifarious are the industries and employments in a country so vast as the United States. I personally know of cases in your country of workmen forced out by labor-saving machines getting immediate employment in making the machines.

Now, turn to the United Kingdom. The laboring population is almost a fixed quantity, both in number and occupations. It is fixed in grooves. Once a bolt maker, always a bolt maker. Moreover, old methods are stoutly adhered to by the workmen. Their wages are comparatively low; their organizations are extensive and powerful. They have, as a rule, set their faces against labor-saving machinery, because the displacement of labor here is regarded by the masses as a very serious thing. I am inclined to so consider it. You can readily see why manufacturers in this country have been conservative. It is not because they have not desired to push ahead, to adopt every new device and every new method, and to run the industries at high pressure. They have simply been afraid to venture. But the tide of iron and steel and other manufactures rolling not only to our colonies, but also into our own markets from the United States, has compelled them to venture. It was a choice between a great, permanent loss of business and the risk of a struggle with labor. At first gradually, then quite largely, they have been importing American machinery, not only for various uses in iron and steel manufacture, but also for wood working, printing, binding, pumping, electric power, rope making, milling, paper making, sailcloth making, shoe making, and so on. They have also been importing, as I have before stated, American tools of all sorts.

"There has been an effort in some quarters to change the plan of work, notably, to dispense with the nine o'clock breakfast, which is expensive, because it generally requires a shutting down of machinery. Stopping and starting in the middle of the forenoon involves a loss, direct and indirect. Moreover, it leads to a dawdling habit on the part of workmen. A straight run from 8 to 1 would be far more productive than a broken run from 7 or even 6:30 to 1. But wherever the change has been proposed, it has, I believe, been resisted. Innovations of any kind are generally opposed sharply, sometimes fiercely. The new labor-saving machinery is as yet not a large part of the total equipment in the more important industries. We have have hardly got beyond the experimental stage, at least so far as the labor question is concerned. There are ominous grumblings. I can not clearly foresee the outcome. If our labor organizations can be made to recognize the absolute necessity confronting British manufacturers for adopting the best machines and the best methods, all may be well, and the labor problem solve itself. Obviously, however, the only solution is the emigration of workmen, unless larger markets for British manufacturers are to be secured in China, Africa and other parts of the world, requiring increased production, and thus giving full employment to men and machinery.

"As everybody is aware, our markets at present are falling away—even the home and colonial markets—and some of our industries are declining. Any hope of expansion or of recovery in the near future seems chimerical, in view of existing conditions and the prospect of an ever-growing foreign competition. What wonder, therefore, that workmen are puzzled to discover any benefit to them in the new order of things? The perfected machinery for production is a matter of immense significance; the expanding markets for British products are as yet a dream. If the majority of skilled working people in the United Kingdom do not abate their hostility to improved machinery, and take the chances of readjustment of the mass of labor to the new mechanical facilities by emigration or otherwise, there is trouble ahead, the consequences of which no man can measure. The engineers' strike, which came to an end in the spring of 1898, threatened the entire fabric of British industries by shaking the confidence of the world and of our own people in their productive power. Another such experience would be disastrous beyond all calculation. Our manufacturers have to face that possibility. I do not put it as a probability, because I am not a pessimist, but prefer to look at the bright side. It were useless, however, to blink the fact that in the industrial revolution now going on brought about chiefly by American competition, there lurks a grave peril."

Ivory Market at Antwerp.—Consul-General Lincoln writes from Antwerp, August 4, 1899:

At the third quarterly sale held on the 2d of August, the ivory offered and sold was as follows:

	Pounds.
Congo:	
Hard	122,997
Soft	7,262
Angola	24,341
Gaboon	4,937
Benguela	520
Senegal and Gold Coast	677
Total	160,734

The totals for the corresponding quarter of preceding years were:

	Pounds.
1898	78,393
1897	158,142
1896	117,743
1895	136,685
1894	94,980
1893	139,011

The prices realized at the London sales last week were exceeded by from 7 to 10 per cent. for the heavy and medium weight tusks, or about 28 to 38 cents per 2·2046 pounds. Tusks for bangles, heavy, realized an increase of about 10 to 38 cents; those for balls, from 19 to 38 cents. The scrivailles were sold with an increase of about 10 cents and the soft ivory about 57 cents per 2·2046 pounds. On the other hand, the tusks for bangles of the light variety decreased somewhat in price.

The stock on hand at the present time is given as 224,869 pounds, as compared with 174,628 pounds in 1898, 154,322 pounds in 1897, 125,662 pounds in 1896, and 317,462 pounds in 1895.

The next quarterly sale will be held on the 31st of October.

Mining in the Yukon Region.—Under date of July 28, 1899, Consul McCook transmits the following:

More men are working on claims this summer than last; they think it more profitable than working in winter. Many good claims have thawing and pumping machinery. The work is continued during the twenty-four hours, and dynamos for electric lighting in the winter are being established. The local government has appropriated $10,000 for the improvement of the trail to Eldorado, and by next winter it is understood that a steam or electric road will be in operation.

Staking by power of attorney was allowed by the Cape Nome Mining Association, and in this way a few men have gained control of an enormous tract of country.

The companies have been cutting wood for their steamers. Along the Yukon, I am informed, there are some 50,000 or 60,000 cords of wood.

Persons who come down the river via Skagway, if not in possession of the necessary $500 or six months' provisions required by the order of the Yukon authorities, must, before passing through Canadian territory via Dawson, make affidavit that they will not stop in Dawson, but proceed to Alaska.

Russian-Siamese Commercial Treaty.—Minister King sends from Bangkok, July 8, 1899, copy of the declaration exchanged between Russia and Siam June 11-23, 1899, which, translated, reads:

The Imperial Government of Russia and the Royal Government of Siam, desiring to facilitate intercourse between the two countries, have agreed upon the following treaty of friendship and of commerce.

That for everything which relates to jurisdiction, to commerce, and to navigation, Russian subjects upon the territory of Siam and Siamese subjects upon the territory of Russia shall enjoy hereafter, until the expiration of the present order, all the rights and privileges granted to subjects of other nations, in Siam or in Russia, by treaties actually in force, as well as by treaties which may be made in the future. This treaty shall go into effect on the day of the signature and continue until the expiration of six months after the day when one or the other of the high contracting parties shall declare its desire to terminate it.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

[Continued from SUPPLEMENT, No. 1242, page 19917.]

DISPLACEMENT OF FLUIDS BY MOVING BODIES.

CONSIDER a transverse section of the moving body, which may be either of regular or irregular outline, at a point where it has the greatest area. The resistance of the fluid, which is constant under like conditions, is in direct proportion to this area. (The factor, K, in the formula $P = K\ S\ V^2$ is due to a change in the degree of the curve generated, as hereafter explained.) This plane of resistance can be considered as being in contact with the displacing section, or removed from it to any given distance, providing its new position is parallel to and directly in front of the displacing section. Now, if this selected section be reduced to its smallest possible limits or considered as the resultant point or point of application of the impelling force, then, also, the plane of resistance is likewise reduced to a point. These points being taken as the points of application of their respective forces, the problem is reduced to one of two opposing forces having the same line of action.

Now, two primary forces acting in the manner indicated are resolved into secondary forces radiating from a point in this line of action and having a common plane of action perpendicular to it, the sum of these secondary forces being equal to that of the two primary forces. If the original forces form a stress instead of a thrust, then the resultant secondary forces act inward instead of outward as before. Yet, in either case, they act in a plane at right angles to the primary line of action.

In the parallelogram of forces the diagonal which represents the resultant force always bisects the angle formed by the respective forces; hence, if this angle be increased to 180°, then will the resultant form angles of 90° with these forces.

If two forces should act through a rigid medium they act in the same manner, though the result observed appears differently. When the cohesion of the particles of this medium at its plane of least resistance is greater than the sum of the two primary forces, the secondary forces generated are countered by this resistence, and are thus resolved into tertiary forces acting at right angles to these secondary forces, and hence having parallel lines of action to the primary forces.

The secondary forces, equal to the sum of the primary forces, being equally divided at the plane of least resistance, as much force is turned back from this place in one direction as in the other. When these forces represent motion, as much movement is created in one direction as in the other, which counteracts the movement of the primary forces, and if these forces be equal, equilibrium ensues. If one of them be greater than the other, then the resulting motion is in the direction of the greater force. If a force of two be applied to one end of a rigid rod and a force of one applied at the other end at some point within the rod, secondary forces are created, whose sum is equal to the sum of the original forces, which is three. These secondary forces in turn are equally divided by the cohesive resistance into tertiary forces acting against the primary forces in lines parallel to the same. Their combined action in each direction being equal to one and a half ($1\frac{1}{2}$). The $-1\frac{1}{2}$ acting against the $+2$ gives $+\frac{1}{2}$, and the $+1\frac{1}{2}$ acting against the -1 gives $+\frac{1}{2}$, these two forces producing motion equal to $+1$, which is motion in the direction of the greater force having the same sign.

Experiments bear out the above facts.

Heat a bar of iron at a certain spot, then simultaneously strike its ends. The bar bulges out or expands at the heated spot, representing planes of least resistance. Again, if this bar be subjected to a stress, the heated part is drawn out or contracted in sectional area, the same as if compression had been applied externally. This same fact is observed in making tests for tensile strength; there is no elongation without a corresponding contraction in area of the transverse section of the bar tested.

If we move two disks toward each other in a fluid, outward currents are created; if we move them apart, inward currents are formed between them.

Take a number of wires of equal length and flexibility and arrange them in a circular cluster, securing their ends so as to prevent separation, then apply force endwise; each one will deflect outward from their central axis.

So, having concluded that the propelling force of the body and the resisting force of the fluid have been resolved into radiating secondary forces, whose plane of action is at right angles to the line of advancement of the body, we will now see where this radiating point or forces is located. We have already seen that it must lie in the line of action between the points of application of the respective forces; hence, it only remains to be determined at what distance from these points. Now, as forces acting on equal masses are directly proportional to the velocities produced, and as these velocities are measured by the distances traversed in equal periods of time, it follows that the distances traversed are proportional to the forces themselves, the greater force representing the greater distance, the lesser force the lesser distance. Therefore, the point is nearest the point of application of the weaker force and furthest from that of the stronger force. If the resistance of the fluid be taken as the unit of measurement of the impelling force and this unit represented by a definite line, then the point of radiation will always be one unit's distance from the resisting plane and as many units distant from the advancing plane as the impelling force is a multiple of the resistance. Thus, if the impelling force be twice as great as the resistance, the point required will be two units' length from point of propulsion.

In fluids forces act equally in all directions. All of these directions are represented in "geometry of three dimensions;" hence, all of the lines of action of these forces can be reduced to resultants coincident with or parallel to a rectangular set of axes. The axes representing breadth and thickness would lie in a plane perpendicular to that of length, and in this plane all forces could be resolved into inward and outward forces in reference to the origin. In the remaining axis only two forces are possible, those acting forward and backward. Hence, it follows that all forces have been considered and disposed of, excepting the inward resistance, this acting against the outward secondary forces gradually diminishes them or retards velocities produced by them. However, though constantly retarded, they are never entirely overcome.

The impelling force, for the moment of consideration, can always be regarded as constant, for it is constantly renewed or generated, receiving an impulse for each one it imparts in the formation of outward force; and a constant force can be assumed to be a succession of blows. A blow imparts its greatest force at moment of impact; hence the outward secondary forces are greatest when first evolved and before they have been retarded by the inward resistance.

Now, the particles of the fluid acted upon by these forces move in the direction in which they act, and have their greatest velocity when these forces are greatest; consequently, they will move furthest from the axis of forward motion the first instant when struck.

From this instant on their outward velocity is uniformly retarded, and the distances traversed in equal periods of time become less and less. Now, each particle so acted upon moves outward in a straight line. Yet, when the relative positions of the particles so acted upon are considered in reference to the constantly advancing focus and to each other, the arc of some curve is described. In this case the branch of a parabola, the origin of which is the advancing point of displacement, established between the impelling force and pressure of the fluid, and whose generating axis is the line of motion of the body.

A number of such parabolic branches equal to the number of secondary forces created form the enveloping surfaces of a paraboloid, the transverse section or displacing dish being the base thereof.

The space so formed forward of the displacing plane and equal to the volume of the paraboloid developed, if not filled out with the matter of which the moving body is composed, will be filled with the fluid itself.

The generally accepted law that the resistance increases as the square of the velocity can be explained as follows: The same object in moving twice as fast must move aside the fluid twice as fast, or in half the time. But, the focus of displacement, the impelling force being considered as doubled, has been moved twice as far ahead, hence the volume of the new paraboloid generated with the same base has been doubled, and we have twice the volume of fluid to be moved in half the time, which requires four times the power. That is, the pressure or resistance has not increased, but the work to be done has increased.

If the displacing section be regular in outline, the surface generated will also be regular; and the regular paraboloid will contain a greater volume per unit of surface developed than the irregular body. As the resisting pressure of the fluid, in the form of work done, has already been considered, the only factor of friction now to be considered is that due to adhesion or cohesion as the case may be.

This is directly proportional to the area of the surface of the paraboloid developed by the transverse section of the moving body. If the surface of the paraboloid so developed is composed of the solid matter of the moving body, then the friction developed by it will be the adhesion of the fluid per unit of area, C, for such matter as the body may consist of multiplied by the entire surface. But, if the paraboloidal space developed is filled out with the fluid, then the frictional coefficient will be the cohesion of the fluid per unit of area of the paraboloid developed by its cross section multiplied by entire surface. As the cohesion of a fluid can differ from its adhesion for particular substances, it will be seen that the shape of a body and the rate at which it moves can be of more importance in determining frictional resistance than the substance of which it consists. A slight variation in shape or speed can change the frictional coefficient, C, from that due to adhesion to that due to cohesion, and vice versa.

The space passed through acts as a multiple of the developed surface, and every time this surface passes through space to the extent of its own length an additional amount of friction equal to the first quantity is overcome. The same amount of power used in the first instance must be used in the second instance, and in each instance the power used is equal to the adhesion per unit of area, C, multiplied by the area, there being no increase of power used there is no increase of friction. Yet if the object be made to move twice as fast the work must be done twice as fast or in half the time, hence the power must be doubled. And if it moves three times as fast, the power must be trebled. Hence, the frictional resistance increases directly as the velocity. This would really be the case if it were not for the fact that surface also increases as the speed increases. Although the length of the developed paraboloid and its volume increase directly with the velocity, the surface does not increase directly. Hence the formula for frictional resistance in fluids should be $R = C\ a\ r\ v$ instead of $R = C\ a\ v^2$. That is, the coefficient of resistance, multiplied by the area, multiplied by its ratio of increase, multiplied by the velocity. As the ratio of increase, r, is so nearly equal to v, being directly dependent on it, the former formula is accurate enough for small surfaces.

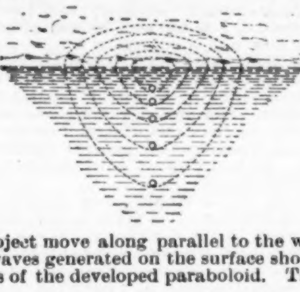
In the formula for volume for paraboloids of revolution, $V = \frac{n}{n+2} \pi\ y^2\ x$, the factor, x, increases directly as the velocity; hence, the volume increases directly as the velocity, and if the surface increased directly as the volume, it also would increase directly as the velocity, and the ratio of increase, r, would be equal to v, and $r\ v$ would be v^2.

The formula for the surface is

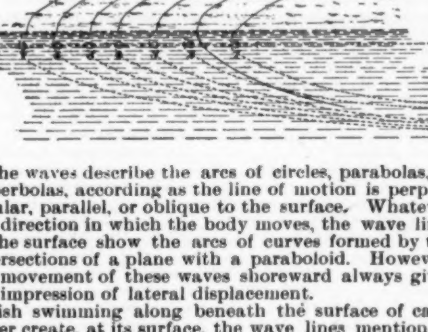
$$S = \frac{2\pi}{3p}\left(b^2 + p^2\right)^{\frac{3}{2}} - p^3.$$

In each of these formulas π is the perimeter of a circle of the radius unity = 3·1416.

As forces and their components are not visible, we can only judge of them by their effects; one of these effects in fluids is wave action. Hence, by observing this action, we can form an accurate idea of the velocities and directions in which the force pulsations act. Let a pebble or shot fall into calm water. The line of direction of the displacing body is downward and is perpendicular to the water's surface. The proof of the existence of the paraboloid, generated by the advancing body and the resistance, is shown by the wave rings on the surface, representing circular base lines at the plane of intersection of the paraboloid with the water's surface, which radiate outward from its line of motion. Thus—



If the object move along parallel to the water's surface, the waves generated on the surface show horizontal sections of the developed paraboloid. Thus—



The waves describe the arcs of circles, parabolas, or hyperbolas, according as the line of motion is perpendicular, parallel, or oblique to the surface. Whatever the direction in which the body moves, the wave lines at the surface show the arcs of curves formed by the intersections of a plane with a paraboloid. However, the movement of these waves shoreward always gives the impression of lateral displacement.

Fish swimming along beneath the surface of calm water create, at its surface, the wave lines mentioned. Should a body move slowly, its point of displacement will be near its section or the base of the paraboloid evolved, and hence its ratio of length to width is reduced and the generated parabolas correspondingly expanded But if the body moves rapidly, the converse is true, the parabolic branches approaching the line of motion.

A ship moving at the rate of two or three knots per hour generates a bow wave which extends outward in a line almost at right angles with its course. When moving at a rate of twelve to fourteen knots per hour, the general direction of this wave line will form an angle of about 45° with its course. And if a higher rate of speed is attained, this angle is still further reduced.

The existence of this invisible wave or force line is shown by the jolt or shock received by one standing near the track of a rapidly passing train. If the person be standing within six or eight feet of the track and the train be passing at a high rate of speed, the impact of this wave is not felt instantly, but not until the engine has passed by some distance. The abruptness and sudden termination of this shock shows the action to be confined to narrow limits, a single line, or surface of action. If a large circular disk were fastened to the pilot of the locomotive and measurements made of the distance from the center of the track to the spot where the observer stands, and also the distance from the disk to a spot on the train that would be directly in front of observer when the impact of the wave is felt, we would have data to establish the shape and size of the paraboloid developed. But, on account of the irregularity of outline of the engine and its parts, there is undoubtedly more than one point of displacement and hence as many paraboloids, whose surfaces intersecting and interfering with each other, break up into the eddying and whirling currents, as shown by the dust clouds developed.

It would also be safe to say that the engine and each car partially opens a way for each succeeding car, so that the atmospheric resistance encountered by a train could only be calculated on some imaginary plane acting as a common center of displacement to all other surfaces present.

A person stationed immediately in front of a displacing surface can be as much in "dead air" as one stationed behind it, for the work done is not in contact with the surface, but at some distance in front of it.

As before stated, the paraboloidal space in front of the displacing section or disk, if not occupied by the solid matter of the body itself, will be filled with the fluid in which it moves. This volume of fluid is moved along with the disk by the propelling force, and any object within this paraboloidal space ("dead air") if it move in unison with the disk will encounter no "head resistance," but if it move at a greater rate of speed than the disk, then it will have a "head resistance" equal to that of a velocity, which is equal to the difference of the respective velocities, and if it move at a slower rate of speed, then the "head resistance" becomes "back pressure," due to difference of velocities. As the volume of fluid back of the disk also moves in unison with it, the physical effects are the same in both cases.

If the fluid be perfect or incompressible, the point of displacement, or the vertex of the paraboloid, advances directly as the impelling force increases. But if it be gaseous (air) it undergoes compression due to the increase of force used to attain velocity and does not advance directly, but the degree of the generating parabolic equation is changed. As this change of the value of the exponent of y in the equation of the parabola, $y\ n = a\ x$, also changes the volume,

$$\left(V = \frac{n}{n+2} \pi\ y^2\ x\right),$$

and surface of the paraboloid,

$$\left(S = \frac{2\pi}{3p}\left(b^2 + p^2\right)^{\frac{3}{2}} - p^3\right).$$

The factor, K, is introduced into the formula for resistance, $R = K\,S\,V^{2}$. In this formula, R means force required to do the work, as the resistance or pressure of the fluid does not vary, excepting for changes of temperature or pressure.

In changing the degrees of the parabolic equation, the curves erected on the same axes are either blunted or sharpened, according as the degree is increased or diminished. When the exponent becomes misty, the equation of the parabola becomes the equation of a straight line passing through the origin. And the nearer the exponent approaches unity the nearer a straight line the parabolic branch becomes.

When it becomes a straight line, the parabola becomes a triangle and the paraboloid of revolution a cone. Now the common supposition is that the higher the velocity the sharper the entrance must be; and hence the nearer unity the exponent of y should be. But the fact is, as the impelling forces increase the vertex of the parabola moves forward, thus sharpening the paraboloid (entrance); but the degree increases also, thus blunting the curves. But as the degree is only slightly increased according as the density due to pressure is increased, the paraboloid (entrance) withal appears to have been sharpened.

As the lines of displacement are established by the cross section and resistance, the lines given the entrance of a vessel can be an impediment or a help to its progress just according as they deviate from or conform to the lines established. The nearer they approximate the true curves established the better the results in the economy of power. M. F. MITHOFF.

(To be continued.)

CATHODIC REVERSER FOR INDUCED CURRENTS.

SINCE the Ruhmkorff coil is a transformer, everything points to the use of it as such when we have an alternating current at our disposal. The condenser and interrupter become useless and the apparatus operates silently and is started instantaneously. The first experiment of this kind seems to have been made by Spottiswoode, with a coil giving a 20-inch spark and actuated by a Meritens alternator. He thus obtained a true flame 7 inches in length and of the diameter of a lead pencil between the terminals of the secondary. This is more than is necessary for making excellent radiographs.

One difficulty presents itself, however. The two induced currents, direct and inverse, given by the coil, are no longer "equal in quantity and unequal in tension" (according to the classical formula), but are identical—direction excepted—and traverse Crookes tubes with the same facility. In order that this high tension alternating current may be utilized, one of the alternations must be arrested, or else (what is evidently preferable) be rendered direct.

The apparatus represented herewith permits of obtaining such a result. The principal element represented in Fig. 1 is a glass bulb of from 25 to 30 cubic inches capacity, provided with two very dissimilar electrodes. With a proper degree of vacuum, comprised between quite wide limits, the electrode, A, placed in the narrow part of the bulb opposes an enormous resistance if it is a cathode, and then allows nothing to pass below 60,000 volts. The spiral, C_1, on the contrary, permits the negative electricity to pass without difficulty, and its resistance corresponds to less than 0·04 of an inch of spark. The cause of such dissymmetry is as follows: A cathode allows of the passage of a current only in proportion to the quantity of cathodic rays that it is capable of giving. As such emission occurs at the expense of the gas that surrounds the electrode, it will be immediately seen that the cathodic discharge may be considerable for C_1, while it is sensibly null for A_1; the glass, in fact, being in nowise fluorescent in the vicinity of the latter.

We have thus a very efficacious electric "valve," capable of withstanding the discharge of a strong coil excited by a current of 25 amperes. It presents at the same time one peculiarity that is entirely favorable to its use. In a Crookes or Geissler tube, the only electrode that becomes heated is the cathode.* In the present case, the latter should have a wide surface (which assures its cooling), and be placed in the widest part of the apparatus. As for the cathodic rays that it emits, they are, by reason of their number, not energetic enough to heat the glass to a dangerous degree, and they do not even render it fluorescent.

This apparatus, as just described, suffices for obtaining the result sought. In fact, it allows the current to pass only in the direction $A_1\ C_1$; and a Crookes tube placed in the circuit in such a manner that its cathode shall be connected at A_1 will be traversed by currents, all in the same direction, to the number of 40 or 50 per second, according to the frequency of the alternating current. Only one alternation out of two is allowed to pass thus. It is evidently preferable to utilize the two induced currents in rendering them direct, which amounts to the same thing as doubling the frequency. The arrangement represented in Fig. 2 completely solves the problem.

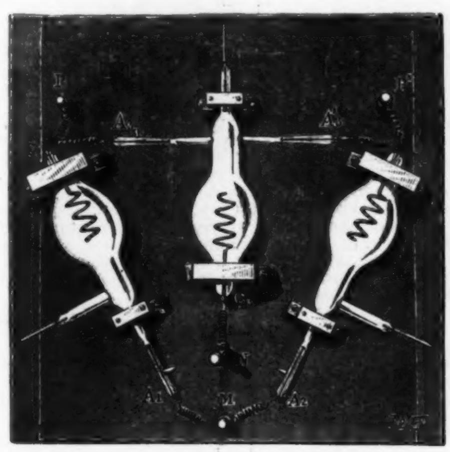


FIG. 2.—ARRANGEMENT OF THE REVERSER.

$A_1\ C_1$, $A_2\ C_2$, simple valves; $C_3\ A_3\ A'_3$, double valves; $P\ P'$, $M\ N$, terminals for the entrance of the alternating currents, and for the exit of the currents that have been rendered direct.

Three bulbs, one of which has two anodes, are fixed upon a board and connected as shown in the figure. P and P' receive the wires that come from the coil or transformer, and M and N are connected with a Crookes tube.

As the electrodes marked A cannot be cathodes, a negative charge entering through P, for example, will necessarily pass through C_1A_1. Having reached this point, it cannot enter the bulb, $A_2\ C_2$, and in order to reach the terminal, P', will be obliged to traverse the Crookes tube interposed between M and N, whence it will reach P' through C_3A_3. Since the apparatus is symmetrical, the course of the negative electricity to the following alternation will evidently be $P'C_2A_2M\ NC_3A_3P$.

The Crookes tube will thus be traversed by currents of invariable direction to the number of from 80 to 100 per second.

The complete installation is represented in Fig. 1. It comprises the reverser, R, the transformer, T, and the Crookes tube, AC. In addition, an ampere meter and a rheostat should be placed in the induction circuit.

The best conditions will evidently be obtained through the use of a true transformer, such as now constructed; but an ordinary Ruhmkorff coil, giving a 16 or 20 inch spark, yields very good results, and so much the better in proportion as the frequency of the alternation is greater—this permitting of raising the primary tensions. It is perhaps not without interest both to radiographers and physicists to have at their disposal a source of electricity giving a current of absolutely invariable direction with a tension of from 40,000 to 50,000 volts.

For the above particulars and the illustrations, we are indebted to La Nature.

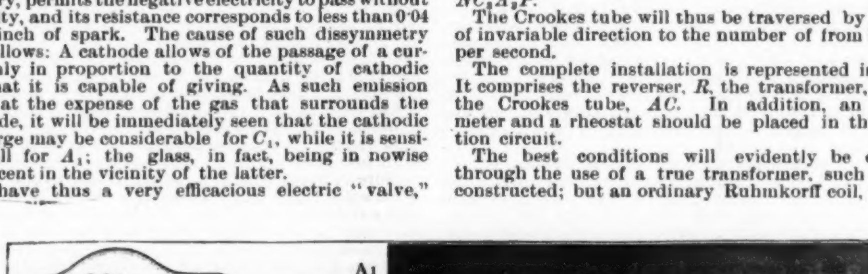


FIG. 1.—CATHODE REVERSER READY FOR OPERATION.

T, transformer or Ruhmkorff coil; R, reverser; $P\ P'$, terminals through which the alternating current enters at a high tension; $M\ N$, terminals through which the reversed currents make their exit; $A\ C$, Crookes tube provided with an osmo-regulator, O. In the corner to the left may be seen the arrangement of one of the electric valves of the reverser.

* In the Crookes tube employed for the production of the X rays, the anode becomes heated solely because it is *anticathode*.

[Continued from SUPPLEMENT, No. 1242, page 19914.]

FIXATION OF CARBON BY PLANTS.*

THE active centers of the decomposition of carbon dioxide in green leaves are the chlorophyl corpuscles or chloroplastids, and the first visible indication of this decomposition is the formation within these chloroplastids of minute granules of starch whose presence can be shown by suitable micro-chemical means. I have elsewhere discussed the question of how far the appearance of this starch is dependent on the pre-existence of other carbohydrates of a simpler constitution, and also the probability that the whole of the products of assimilation do not necessarily pass through the form of starch; this is a subject which need scarcely concern us at the present moment; it is sufficient to draw attention to the main fact that in an assimilating cell the chloroplastids, in the vast majority of cases, give rise to these minute starch granules, which once more disappear when the plant is placed in darkness, or when the air around it is deprived of carbon dioxide. Now in 1883 Böhm made the interesting discovery that when green leaves are placed in the dark until the starch of their chloroplastids has completely disappeared, there is a reappearance of starch when the cut end of the leaf-stalk is immersed in a solution of cane sugar and of dextrose, or when the leaf is brought directly in contact with solutions of these substances. He found, in fact, that the elements of the cell which, under ordinary circumstances, manufacture their materials for plant growth by the reduction of carbon dioxide under the influence of sunlight, can, under other conditions, supply their requirements from suitable ready formed organic substances. These observations of Böhm were fully confirmed two years later by Schimper, and were subsequently much extended by A. Meyer and E. Laurent, who found that fructose, maltose, mannitol, dulcitol, and glycerol could also contribute directly to the nutrition of leaves.

Bokorny, working with Spirogyra immersed in dilute solutions, found that starch production in the chlorophyl bodies could be induced by a large number of organic substances, including, among many others, asparagin, citric, tartaric, and lactic acids, leucine, tyrosine, and peptone.†

Very much more to the point are the experiments of Acton made in 1889, and the still more recent work of J. Laurent and of Mazé.

In his experiments on terrestrial plants, Acton, after depleting them of starch, immersed the cut branches or roots, as the case might be, in culture fluids containing certain organic substances, and took precautions to prevent any normal assimilation from taking place by depriving the air around the plant of any trace of carbon dioxide. He was not able to show the direct nutritive influence of so large a range of substances as Bokorny had done for Spirogyra, but his results leave no room for doubt that several of the carbohydrates, and even glycerine, can be absorbed by the roots, and can contribute to the nutrition of the green parts. Acton tried, among other substances, an "extract of natural humus," which was an aqueous solution of the extractives of a light soil which are soluble in dilute alcohol. This extract was found to be effective in producing a small quantity of starch in the leaves, and it evidently contained some substance or substances directly assimilable by the plant.

Apparently without knowing anything of this work of Acton, J. Laurent has recently made a series of experiments on the culture of the maize plant in mineral solutions containing saccharose, glucose, or invert-sugar, and in this way has not only obtained, as Acton had done before him, evidence of the active formation of starch in the leaves, but has also found a very notable increase in the dry weight of the plant. Although assimilation of the carbohydrates may under these circumstances go on in darkness, Laurent found that the process was much enhanced when light had access to the plant. Mazé, within the last few months, has obtained even more pronounced effects of this kind.

When all these new facts are taken into consideration, I think they justify what I have already said, that we ought to demand more direct evidence than is at present available before we accept the view that the majority of chlorophylous plants take in the whole of their carbon from the atmosphere. In the cycle of change which the organic matter of the soil is constantly undergoing under the influence of micro-organisms, it seems by no means improbable that intermediate substances may be formed which in some measure directly contribute to the nutrition of the higher plants, and we must also by no means lose sight of the possible effect, in the same direction, of the symbiotic union of certain fungi with the root extremities of many plants, the Mycorhizæ, whose functions are still so imperfectly understood. Then, again, we must remember that we have another possible extra atmospheric source of carbon dioxide in the transpiration water of the plant, which is derived from a soil whose gases may contain 5 per cent. or more of carbon dioxide. From the amount of water transpired in a given time, and an application of the law of partial pressures, it may be readily shown that the supply of carbon dioxide to the aerial organs of a plant from this source is by no means negligible.

Before these problems can be attacked for a particular plant with any hope of success, it is clear that we must have some means of establishing an accurate debtor and creditor account as between the plant and the surrounding atmosphere, and this account must extend over a sufficiently long period, and allow of an accurate balance being struck with the amount of carbon found in the plant at the end of the experiment.

Up to within a few years ago we had no means of even approximately determining the actual rate at

* Opening address by Dr. Horace T. Brown, F.R.S., President of the Chemical Section.

† By far the most interesting and important result of Bokorny is the proof he gives that formaldehyde is directly assimilable by Spirogyra. His early attempts to show this had been rendered abortive by the highly poisonous nature of this substance. The difficulty was surmounted by using a dilute solution of sodium oxymethylsulphonate, which on warming with water splits up into formaldehyde and acid sodium sulphite. To prevent the unfavorable action of the acid sodium sulphite, dipotassium or disodium phosphate was added to the plant cultures. In such a solution, with rigid exclusion of carbon dioxide, Spirogyra majuscula forms starch in its chlorophyl bodies, but the access of light appears to be necessary.

The importance of this experiment is very great in connection with Baeyer's well-known hypothesis that the first act of assimilation is the reduction of carbon dioxide and water to the state of formaldehyde.

which the assimilatory process goes on in a plant other than that afforded by its increase in weight in a given time. Such experiments, necessarily extending over weeks or months, can, at the best, only give us certain average results, and consequently afford no measure of the activity of assimilation under fixed conditions of insolation. In the year 1884, Sachs, who had for some time been at work on the formation of starch in leaves under the action of sunlight, found that the accumulation of freshly assimilated material in a leaf may, under favorable conditions, go on so rapidly as to give rise to a very appreciable increase of weight in the leaf lamina within the short space of a few hours. By observing at different times of the day the varying dry weight of equal areas of large leaves, Sachs obtained an approximate measure of the rate of the assimilatory process which he could express in terms of actual number of grammes of substance assimilated by a unit area of leaf in unit of time. In this manner he was able to show, for instance, that a sunflower leaf, while still attached to the plant, increases in weight when exposed to bright sunshine at the hourly rate of about one gramme per square meter of leaf area. In the case of similar leaves detached from the plant, and of course under conditions in which the products of assimilation were entirely accumulated in the leaf, he found an increase in weight of rather more than 1½ grammes per square meter per hour.

I was able to confirm this work of Sachs in the course of an investigation on the Chemistry of Leaves which I made with Dr. G. H. Morris in 1892-93, and there can be no doubt that the variations in the weight of leaves can be used as a fair index of the activity of a leaf in assimilating, but it is not a method which admits of much refinement of accuracy, owing, among other things, to the want of perfect symmetry in the leaves as regards thickness and density of the laminæ and to the possible migration of the assimilated material into the larger ribs, which of course cannot be included in the weighings.

It is evident that a far better plan of measuring the rate of assimilation under varying conditions would be the estimation of the actual amount of carbon dioxide entering a given area of the leaf in a certain time, and it was to the perfection of a method of this kind that Mr. Escombe and I first turned our attention.

In all previous attempts to measure the rate of ingress of carbon dioxide, such as those of Corenwinder, and more recently still of Mr. F. F. Blackman, it has been necessary to use air containing comparatively large quantities of carbon dioxide, amounting to 4 per cent. and upwards. Interesting and useful as such experiments undoubtedly are from the point of view from which they were undertaken, we must not lose sight of the fact that such conditions are highly artificial, and very far removed from those under which a plant finds itself in the natural state, where its leaves are bathed with air containing not 4 or 5 per cent. but only 0·03 per cent. of carbon dioxide. I shall have occasion later on to show how remarkably the rate of intake of carbon dioxide into a plant is influenced by extremely small variations in the tension of that gas, and that on this account no deduction can be drawn as to the rate of assimilation under natural conditions from any experiments in which the air contains even so small an amount of carbon dioxide as 1 per cent.

Before proceeding further in this direction, however, it will be well to consider the amount of carbon dioxide which must enter a leaf in a given time in order to produce an influence on its weight comparable with that indicated by the Sachs method of weighing definite areas. For this purpose I will consider a leaf with which we have made many experiments—that of Catalpa bignonioides. It is a very symmetrical leaf and a good assimilator, and since the intake of carbon dioxide takes place only on the under side, the question to which I wish to draw your attention can be stated in a simple manner. When such a leaf is subjected to a modified form of the half leaf weighing method of Sachs, into the details of which I cannot here enter, it may, under favorable conditions, show an increase in dry weight equal to about one gramme per square meter per hour. Since this increase in weight is due almost entirely to the formation of carbohydrates, we can calculate with a close approximation to accuracy the corresponding amount of carbon dioxide. This will of course depend within certain narrow limits, on the nature of the carbohydrate formed. The formation of a gramme of starch requires 1·628 grammes of carbon dioxide, while an equal amount of a $C_6H_{12}O_6$ or a $C_{12}H_{22}O_{11}$ sugar require 1·406 and 1·543 grammes respectively. From the knowledge we possess of the nature of the carbohydrates of the leaf, we are quite sure that the mean of these values, that is 1·545 grammes, must be very near the truth. This amount corresponds to 784 c. c. of carbon dioxide at normal temperature and pressure, which must represent the column abstracted by the square meter of leaf surface in one hour from air containing only three parts of carbon dioxide in 10,000 supposing the method of leaf weighing to give correct results. We shall see later on that this intake can be verified by direct estimations; it is equivalent to the total amount of carbon dioxide in a column of air of a cross-section equal to that of the leaf, and of a height of 26 decimeters.

The extraordinary power which an assimilating leaf possesses of abstracting carbon dioxide from the air is best shown by comparing it with an equal area of a freely exposed solution of caustic alkali. We have made a very large number of experiments on the rate at which atmospheric carbon dioxide can be taken up by a solution of caustic soda under varying conditions, and have been surprised to find how constant the absorption is. In a moderately still air a square meter of surface of such a freely exposed solution will absorb about 1,200 c. c. of carbon dioxide per hour, and this can only be increased to about 1,500 c. c. even if the dish is exposed to the full influence of a strong wind out in the open. When the surface of the liquid is constantly renewed during the experiments by means of a mechanical stirrer, the rate of absorption is not sensibly affected, providing the agitation does not appreciably increase the surface area, and considerable variations in the strength of the alkaline solution are also without any effect. On the other hand, slight variations in the tension of the carbon dioxide of the air have a marked influence on the rate of absorption, and in order to study this point we have constructed an apparatus which allows us to pass over an absorptive surface of liquid a current of air in a stratum of known thickness, and with a known average velocity.

By introducing definite amounts of carbon dioxide into this stream of air we have been able to determine the influence of its tension on the rate of absorption. At present we have only employed air containing amounts varying from 0·8 to 13 parts per 10,000 that is to say, from about one-quarter to a little more than four times the amount contained in normal air. Within these limits, and probably beyond them, the rate of absorption by the alkaline surface is strictly proportional to the tension of the carbon dioxide in the air current. I shall have occasion to show later on that the same rule holds good with regard to an assimilating leaf, and that in this case also, within certain limits, the intake of the gas is proportional to its tension.

The act which I wish more particularly to bring out in these comparisons is that a leaf surface which is assimilating at the rate of one gramme of carbohydrate per square meter per hour is absorbing atmospheric carbon dioxide more than half as fast as the same surface would do if wetted with a constantly renewed film of a strong solution of caustic alkali.

From what I have just said about the influence of tension on the absorption of carbon dioxide by an assimilating leaf, it is clear that any attempts to determine by direct means the natural intake of that gas during assimilation must be made with ordinary air, and that such experiments can only be carried out on a comparatively large scale. We had in the first instance to devise an apparatus which would rapidly and completely absorb the whole of the carbon dioxide from a stream of air passing through it at the rate of from 100 to 200 liters per hour, and at the same time admit of an extremely accurate determination of the absorbed carbon dioxide.

The absorbing apparatus which we finally adopted is a modification of one used by Reiset in his estimations of the carbon dioxide of the atmosphere. It consists essentially of a glass tube 50 cm. long, fixed vertically in a wide-mouthed glass vessel furnished with a second aperture and tubulure. The height of the vertical tube is invariable, but its width is regulated according to the amount of air required to be drawn through the apparatus in a given time. The bottom of this tube is closed with a platinum or silver plate pierced with a large number of very small holes, and two other similar perforated plates are inserted in the tube at certain intervals. The upper part of the tube is put in connection with an aspirating water-pump, and the absorbing liquid is placed in the lower glass vessel, whose second tubulure is connected with the supply of air in which the carbon dioxide has to be determined. When the aspirator is started the liquid is first drawn up into the vertical tube, and the air then follows through the perforated plates which act as "scrubbers." Reiset, in his work, used baryta water as the absorbent, an aliquot part of which was titrated before and after the experiment, the changes in the volume of the liquid being corrected for by certain devices which I need not describe.

The efficiency of the apparatus as a complete absorber of atmospheric carbon dioxide leaves nothing to be desired, but in dealing with large quantities of baryta solution, amounting to 400 c. c. or more, the errors due to inaccurate titrations, or to over or under estimation of the volume changes, are all thrown on the final result, of which they may form a considerable part. We have consequently altogether discarded the use of baryta as an absorbent in favor of caustic soda. The carbonate is estimated by a double titration process, suggested a few years ago by Hart, and we have succeeded in so far improving this method that there is no difficulty in determining in 100 c. c. of the alkaline solution an amount of carbonate corresponding to $\frac{1}{10}$ c. c. of carbon dioxide.

There is practically no limit to the amount of air which can be passed through an absorbing apparatus such as I have described, and one of very moderate dimensions will allow from 100 to 150 liters per hour to pass with perfect safety. Larger amounts can be dealt with either by increasing the size of the apparatus or by using several smaller ones arranged in parallel.

With proper precautions, determinations can certainly be made to within 0·02 part of carbon dioxide in 10,000 of air, so that with an apparatus of this kind it is possible to estimate the intake of carbon dioxide into a leaf or plant from ordinary atmospheric air, and to keep a sufficiently rapid stream of air passing over the leaf to maintain the tension of the carbon dioxide only slightly below the normal amount.

The air is measured by carefully standardized meters, reading to about 20 c. c.; and since the amounts of air aspirated vary from 100 to 900 liters or more, there are practically no errors of measurement. The tension at which the air passes through the absorption apparatus is measured by a manometer, and all the volumes are reduced to standard temperature and pressure.

All such experiments of course necessitate, not only a determination of the carbon dioxide in the air which has passed over the leaf or plant, but also a simultaneous determination of the carbon dioxide in the ordinary air used. The accumulation of these air determinations clearly shows that the ordinary statements of our text-books as to the amount of carbon dioxide and its limits of variation are altogether misleading.

In our experiments the air was in all cases taken from a height of four feet six inches from the ground, the amounts aspirated varying from 100 to 500 liters.

In the month of July, 1898, the minimum amount of carbon dioxide found was 2·71 parts per 10,000 of air, and the maximum 2·86. During the winter months, when the ground was almost bare of vegetation, it rose to from 3·00 to 3·23 parts per 10,000; and on one foggy day, March 16, 1899, after a whole week of similar weather, we found the very exceptional amount of 3·62. As a rule, we may take it that the amount of carbon dioxide in the atmosphere during the period of greatest plant growth rarely falls short of 2·7 parts per 10,000, and rarely exceeds 3·0 parts, with an average of about 2·85. These numbers come very close to the determination of Reiset, and of Müntz and Aubin, and agree also fairly well with the Montsouris determinations.

If instead of taking the air from a height of three or four feet from the ground, we examine the stratum only one or two centimeters above the surface of a soil free from vegetation, we find, as might be expected, a very large increase in the amount of carbon dioxide, which may exceed, under these circumstances, 12 or 13 parts per 10,000 of air. Such a soil, in fact, gives off by diffusion into the surrounding air an amount of carbon dioxide which is comparable to that evolved by a respiring leaf, that is to say, about 50 c. c. per square meter per hour. This is probably a factor which has to be taken into account in considering the assimilative power of vegetation of very low growing habit, but in all other cases we may assume with safety that aerial plants have to take in their carbon dioxide from air in which its tension does not exceed $\frac{3}{10000}$ of an atmosphere.

The actual intake of carbon dioxide is determined by enclosing the entire leaf in specially constructed air-tight, glazed cases, through which a sufficiently rapid air stream is passed. These cases are so arranged that the leaf can be enclosed while still attached to a plant which is growing out in the open under perfectly natural conditions, and some of them are sufficiently large to take the entire leaf of a sunflower.

The carbon dioxide content of the air is determined both before and after its passage through the apparatus, and since the amount of air passed is known we have all the data requisite for determining the actual amount retained by the leaf.

An experiment generally lasts from five to six hours, and the carbon dioxide fixed in this time may amount to 150 c. c. or more, the actual error of determination being very small indeed.

For purposes of comparison the volumes are reduced to the actual number of cubic centimeters of the gas absorbed by a square meter of leaf in one hour, which of course necessitates an exact determination of the area of the leaf. This is most conveniently effected by printing the leaf on sensitized paper, and tracing round its outline with a planimeter set to read off square centimeters—a far more accurate and expeditious plan than that of cutting out a fac-simile of the leaf from paper of a known weight per unit of area.

If it is desired to estimate the assimilative power of a leaf in an atmosphere artificially enriched with carbon dioxide, the air stream before entering the leaf case is passed through a small tower containing fragments of marble, over which there drops a very slow stream of dilute acid, whose rate of flow is so proportioned to the air stream as to give about the desired enrichment with carbon dioxide. The stream of air is then divided, one part going on directly to the leaf case, while the other passes through a separate absorption apparatus and meter for the accurate determination of its carbon dioxide content.

In order to show the kind of results obtained in this manner, I will give one or two examples.

A leaf of the sunflower, having an area of 617·5 sq. cm., was enclosed in its case, while still attached to the plant, and was exposed to the strong diffuse light of a clouded sky for five and a half hours, air being passed over it at the rate of nearly 150 liters per hour. The content of the air in carbon dioxide as it entered the apparatus was 2·80 parts per 10,000, and this was reduced to 1·74 parts per 10,000 during its passage over the leaf. This corresponds to a total absorption of 139·95 c. c. of carbon dioxide, or to an intake of 412 c.c. per square meter per hour. If we assume that the average composition of the carbohydrates formed is that of a $C_6H_{12}O_6$ sugar, the above amount of carbon dioxide corresponds to the formation of 0·55 gramme of carbohydrate per square meter per hour. But we must bear in mind that the average tension of the carbon dioxide in the leaf case was only equal to 1·93 parts per 10,000—that is, only about seven-tenths of its tension in the normal air. A correction has therefore to be made if we wish to know how much the leaf would have taken in, under similar conditions of insolation, if it had been bathed with a current of air of sufficient rapidity to practically keep the amount of carbon dioxide constant at its normal amount of 2·8 per 10,000. We shall see later on that, well within the limits of this experiment, the intake is proportional to the tension, so that applying this correction we may conclude that under identical conditions of insolation and temperature this leaf would have taken in an amount of carbon dioxide from the free air at a rate sufficient to produce 0·8 gramme of carbohydrate per square meter per hour. This is almost exactly equal to the assimilation rate of the sunflower which I deduced in 1892 from the indirect process of weighing equal areas of the leaf lamina before and after insolation, and it also agrees fairly well with some of Sachs' original experiments of a similar nature.

In another experiment made with the leaf of Catalpa bignonioides in full sunlight, the amount of carbon dioxide in the air passing over the leaf fell from 2·80 to 1·79 parts per 10,000, the total hourly intake for the square meter being 344·8 c. c. When this is corrected for tension, it corresponds to an assimilation in free air of 0·55 gramme, of carbohydrate per square meter per hour.

An increase in the intensity of the daylight, as might be expected, influences to some extent the rate of intake of atmospheric carbon dioxide: but providing the illumination has reached a certain minimum amount, a further increase in the radiant energy incident on the leaf does not result in anything like a proportional amount of assimilation. We have found, for instance, that the rate of assimilation of a sunflower leaf exposed to the clear northern sky on a warm summer's day, was about one-half of what it was when the leaf was turned round so as to receive the direct rays of the sun almost normal to its surface. Now in this latter case the actual radiant energy received by the leaf was at least twelve times greater than was received from the northern sky, but the assimilation was only doubled.

These differences in the effect of great variation of illumination become still less marked when we use air which has been artificially enriched with carbon dioxide. In one instance of this kind, for example, we found the assimilation in the full diffuse light of the northern sky to be 87 per cent. of what it was in direct sunshine.

(To be continued.)

The initial experiments with the turbine torpedo boats are looked forward to with great interest. The first test will be made in November, when the "Viper" will be run over a measured mile. She is fitted with four shafts, each carrying two propellers and each driven by four steam turbines.

CHEMICAL AND BACTERIOLOGICAL EXAMINATION OF WATER AND SEWAGE.*

IT is desirable that results of analysis should be expressed in parts per 100,000, except in the case of dissolved gases, when these should be stated as cubic centimeters of gas at 0° C. and 760 mm. in one liter of water. This method of recording results is in accordance with that suggested by the committee appointed in 1887 to confer with the committee of the American Association for the Advancement of Science, with a view to forming a uniform system of recording the results of water analysis.† The committee suggest that in the case of all nitrogren compounds the results be expressed as parts of nitrogen over 100,000, including the ammonia expelled on boiling with alkaline permanganate, which should be termed albuminoid nitrogen. The nitrogen will, therefore, be returned as: (1) Ammoniacal nitrogren from free and saline ammonia; (2) nitrous nitrogen from nitrites; (3) nitric nitrogen from nitrates; (4) organic nitrogen (either by Kjeldal or by combustion, but the process used should be stated); (5) albuminoid nitrogen. The total nitrogen of all kinds will be the sum of the first four determinations. The committee are of opinion that the percentage of nitrogen oxidized—that is, the ratio of 2 and 3 to 1 and 4—gives sometimes a useful measure of the stage of purification of a particular sample. The purification effected by a process will be measured by the amount of oxidized nitrogen as compared with the total amount of nitrogen existing in the crude sewage. In raw sewage and in effluents containing suspended matter it is also desirable to determine how much of the organic nitrogen is present in the suspended matter.

In sampling, the committee suggest that the bottles should be filled nearly completely with liquid, only a small air bubble being allowed to remain in the neck of the bottle. The time at which a sample is drawn, as well as the time at which its analysis is begun, should be noted. An effluent should be drawn to correspond as nearly as possible with the original sewage, and both it and the sewage should be taken in quantities proportional to the rate of flow when that varies (e. g., in the emptying of a filter bed). In order to avoid the multiplication of analyses, the attendant at a sewage works (or any other person who draws the samples) might be provided with sets of 12 or 24 stoppered ½ Winchester bottles, one of which should be filled every hour or every two hours, and on the label of each bottle the rate of flow at the time should be written. When the bottles reach the laboratory, quantities should be taken from each proportional to these rates of flow, and mixed together, by which means a fair average sample for the twenty-four hours would be obtained. The committee at present are unable to suggest a method of reporting bacterial results, including incubator tests, which is likely to be acceptable to all workers.

Dr. Samuel Rideal, the secretary, in sending this report to The Times, writes: "The committee are anxious that all official reports in this country shall be reported in a similar manner, as it will then enable such reports to be compared with one another without calculation. It will be noticed that the report urges the adoption of the system of recording the results adopted originally by the Rivers Pollution Commission, and which was confirmed by the committee of the American Association for the Advancement of Science in 1887, and I believe it is no breach of confidence for me to add that the Royal Commission at present sitting will also conform to these suggestions. A further advantage of the 'parts per 100,000' over 'grains per gallon' is that continental results are always recorded in this manner. The committee hope next year to supplement this report by further recommendations to cover those other points not embodied in the present report, and, as secretary of the committee, I shall be glad to receive the views of other workers to lay before the committee."

[Continued from SUPPLEMENT, No. 1242, page 19918.]

THE PROGRESS OF SCIENCE AND ITS RESULTS.‡

By Prof. SIR MICHAEL FOSTER, K.C.B., Sec.R.S.

PROBLEMS OF THE LIVING BODY.

In another branch of science, in that which deals with the problems presented by living beings, the thoughts of men in 1799 were also very different from the thoughts of men to-day. It is a very old quest, the quest after the knowledge of the nature of living beings, one of the earliest on which man set out; for it promised to lead him to a knowledge of himself, a promise which perhaps is still before us, but the fulfillment of which is as yet far off. As time has gone on, the pursuit of natural knowledge has seemed to lead man away from himself into the furthermost parts of the universe, and into secret workings of Nature in which he appears to be of little or no account; and his knowledge of the nature of living things, and so of his own nature, has advanced slowly, waiting till the progress of other branches of natural knowledge can bring it aid. Yet in the past hundred years the biologic sciences, as we now call them, have marched rapidly onward.

We may look upon a living body as a machine doing work in accordance with certain laws, and may seek to trace out the working of the inner wheels, how these raise up the lifeless dust into living matter, and let the living matter fall away again into dust, giving out movement and heat. Or we may look upon the individual life as a link in a long chain, joining something which went before to something about to come, a chain whose beginning lies hid in the farthest past, and may seek to know the ties which bind one life to another. As we call up to view the long series of living forms, living now or flitting like shadows on the screen of the past, we may strive to lay hold of the influences which fashion the garment of life. Whether the problems of life are looked upon from the one point of view or the other, we to-day, not biologists only, but all of us, have gained a knowledge hidden even from the philosophers a hundred years ago.

Of the problems presented by the living body viewed as a machine, some may be spoken of as mechanical, others as physical, and yet others as chemical, while some are, apparently at least, none of these. In the seventeenth century William Harvey, laying hold of the central mechanism of the blood stream, opened up a path of inquiry which his own age and the century which followed trod with marked success. The knowledge of the mechanics of the animal and of the plant advanced apace; but the physical and chemical problems had yet to wait. The eighteenth century, it is true, had its physics and its chemistry; but, in relation at least to the problems of the living being, a chemistry which knew not oxygen, and a physics which knew not the electricity of chemical action, were of little avail. The philosopher of 1799, when he discussed the functions of the animal or of the plant involving chemical changes, was fain for the most part, as were his predecessors in the century before, to have recourse to such vague terms as "fermentation" and the like; to-day our treatises on physiology are largely made up of precise and exact expositions of the play of physical agencies and chemical bodies in the living organism. He made use of the words "vital force" or "vital principle" not as an occasional, but as a common, explanation of the phenomena of the living body. During the present century, especially during its latter half, the idea embodied in those words has been driven away from one seat after another; if we use it now when we are dealing with the chemical and physical events of life, we use it with reluctance, as a deus ex machina to be appealed to only when everything else has failed.

Some of the problems—and those, perhaps, the chief problems—of the living body have to be solved neither by physical nor by chemical methods, but by methods of their own. Such are the problems of the nervous system. In respect to these the men of 1799 were on the threshold of a pregnant discovery. During the latter part of the present century, and especially during its last quarter, the analysis of the mysterious processes in the nervous system, and especially in the brain, which issue as feeling, thought, and the power to move, has been pushed forward with a success conspicuous in its practical, and full of promise in its theoretical gains. That analysis may be briefly described as a following up of threads. We now know that what takes place along a tiny thread which we call a nerve fiber differs from that which takes place along its fellow threads, that differing nervous impulses travel along different nerve fibers, and that nervous and psychical events are the outcome of the clashing of nervous impulses as they sweep along the closely woven web of living threads of which the brain is made. We have learned by experiment and by observation that the pattern of the web determines the play of the impulses, and we can already explain many of the obscure problems not only of nervous disease, but of nervous life, by an analysis which is a tracking out the devious and linked paths of nervous threads. The very beginning of this analysis was unknown in 1799. Men knew that nerves were the agents of feeling and of the movements of muscles; they had learned much about what this part or that part of the brain could do; but they did not know that one nerve fiber differed from another in the very essence of its work. It was just about the end of the past century, or the beginning of the present one, that an English surgeon began to ponder over a conception which, however, he did not make known until some years later, and which did not gain complete demonstration and full acceptance until still more years had passed away. It was in 1811, in a tiny pamphlet published privately, that Charles Bell put forward his "New Idea" that the nervous system was constructed on the principle that "the nerves are not single nerves possessing various powers, but bundles of different nerves, whose filaments are united for the convenience of distribution, but which are distinct in office as they are in origin from the brain."

Our present knowledge of the nervous system is to a large extent only an exemplification and expansion of Charles Bell's "New Idea," and has its origin in that.

If we pass from the problems of the living organism viewed as a machine to those presented by the varied features of the different creatures who have lived, or who still live on the earth, we at once call to mind that the middle years of the present century mark an epoch in biologic thought such as never came before, for it was then that Charles Darwin gave to the world the "Origin of Species."

That work, however, with all the far-reaching effects which it has had, could have had little or no effect, or, rather, could not have come into existence, had not the earlier half of the century been in travail preparing for its coming. For the germinal idea of Darwin appeals, as to witnesses, to the results of two lines of biologic investigation which were almost unknown to the men of the eighteenth century.

To one of these lines I have already referred. Darwin, as we know, appealed to the geological record; and we also know how that record, imperfect as it was then, and imperfect as it must always remain, has since his time yielded the most striking proofs of at least one part of his general conception. In 1799 there was, as we have seen, no geological record at all.

Of the other line I must say a few words.

To-day the merest beginner in biologic study, or even that exemplar of acquaintance without knowledge, the general reader, is aware that every living being, even man himself, begins its independent existence as a tiny ball, of which we can, even acknowledging to the full the limits of the optical analysis at our command, assert with confidence that in structure, using that word in its ordinary sense, it is in all cases absolutely simple. It is equally well known that the features of form which supply the characters of a grown-up living being, all the many and varied features of even the most complex organism, are reached as the goal of a road, at times a long road, of successive changes; that the life of every being, from the ovum to its full estate, is a series of shifting scenes, which come and go, sometimes changing abruptly, sometimes melting the one into the other, like dissolving views, all so ordained that often the final shape with which the creature seems to begin, or is said to begin, its life in the world is the outcome of many shapes, clothed with which it in turn has lived many lives before its seeming birth.

All, or nearly all, the exact knowledge of the labored way in which each living creature puts on its proper shape and structure is the heritage of the present century. Although the way in which the chick is moulded in the egg was not wholly unknown even to the ancients, and in later years had been told, first in the sixteenth century by Fabricius, then in the seventeenth century in a more clear and striking manner by the great Italian naturalist Malpighi, the teaching thus offered had been neglected or misinterpreted. At the close of the eighteenth century the dominant view was that in the making of a creature out of the egg there was no putting on of wholly new parts, no epigenesis. It was taught that the entire creature lay hidden in the egg, hidden by reason of the very transparency of its substance, lay ready made but folded up, as it were, and that the process of development within the egg or within the womb was a mere unfolding, a simple evolution. Nor did men shrink from accepting the logical outcome of such a view—namely, that within the unborn creature itself lay in like manner, hidden and folded up, its offspring also, and within that again its offspring in turn, after the fashion of a cluster of ivory balls carved by Chinese hands, one within the other. This was no fantastic view put forward by an imaginative dreamer; it was seriously held by sober men, even by men like the illustrious Haller, in spite of their recognizing that as the chick grew in the egg some changes of form took place. Though so early as the middle of the eighteenth century Friedrich Caspar Wolff, and, later on, others had strenuously opposed such a view, it held its own not only to the close of the century, but far on into the next. It was not until a quarter of the present century had been added to the past that Von Baer made known the results of researches which once and for all swept away the old view. He, and others working after him, made it clear that each individual puts on its final form and structure not by an unfolding of pre-existing hidden features, but by the formation of new parts through the continued differentiation of a primitively simple material. It was also made clear that the successive changes which the embryo undergoes in its progress from the ovum to maturity are the expression of morphologic laws, that the progress is one from the general to the special, and that the shifting scenes of embryonic life are hints and tokens of lives lived by ancestors in times long past.

If we wish to measure how far off in biologic thought the end of the last century stands, not only from the end, but even from the middle of this one, we may imagine Darwin striving to write the "Origin of Species" in 1799. We may fancy him being told by philosophers, explaining how one group of living beings differed from another group because all its members and all their ancestors came into existence at one stroke when the first born progenitor of the race, within which all the rest were folded up, stood forth as the result of a creative act. We may fancy him listening to a debate between the philosopher who maintained that all the fossils strewn in the earth were the remains of animals or plants churned up in the turmoil of a violent universal flood, and dropped in their places as the waters went away, and him who argued that such were not really the "spoils of living creatures," but the products of some playful plastic power which, out of the superabundance of its energy fashioned here and there the lifeless earth into forms which imitated, but only imitated, those of living things. Could he, amid such surroundings, by any flight of genius have beat his way to the conception for which his name will ever be known?

A DIFFERENCE WHICH MEANS PROGRESS.

Here I may well turn away from the past. It is not my purpose, nor, as a have said, am I fitted, nor is this perhaps the place, to tell even in outline the tale of the work of science in the nineteenth century. I am content to have pointed out that the two great sciences of chemistry and geology took their birth, or at least began to stand alone, at the close of the last century, and have grown to be what we know them now within about a hundred years, and that the study of living beings has within the same time been so transformed as to be to-day something wholly different from what it was 1799. And, indeed, to say more would be to repeat almost the same story about other things. If our present knowledge of electricity is essentially the child of the nineteenth century, so also is our present knowledge of many other branches of physics. And those most ancient forms of exact knowledge, the knowledge of numbers and of the heavens, whose beginning is lost in the remote past, have, with all other kinds of natural knowledge, moved onward during the whole of the hundred years with a speed which is ever increasing. I have said, I trust, enough to justify the statement that in respect to natural knowledge a great gulf lies between 1799 and 1899. That gulf, moreover, is a twofold one; not only has natural knowledge been increased, but men have run to and fro spreading it as they go. Not only have the few driven far back round the full circle of natural knowledge the dark clouds of the unknown which wrap us all about, but also the many walk in the zone of light thus increasingly gained. If it be true that the few to-day are, in respect to natural knowledge, far removed from the few of those days, it is also true that nearly all which the few alone knew then, and much which they did not know, has now become the common knowledge of the many.

What, however, I may venture to insist upon here is that the difference in respect to natural knowledge, whatever be the case with other differences between then and now, is undoubtedly a difference which means progress. The span between the science of that time and the science of to-day is beyond all questions a great stride onward.

We may say this, but we must say it without boasting. For the very story of the past which tells of the triumphs of science bids the man of science put away from him all thoughts of vainglory. And that by many tokens.

Whoever working at any scientific problem, has occasion to study the inquiries into the same problem

* Interim report of a committee appointed by the British Association to establish a uniform system of recording the results of the chemical and bacteriological examination of water and sewage, consisting of Prof. W. Ramsay (chairman), Dr. Rideal (secretary), Sir William Crookes, Prof. Frank Clowes, Prof. Percy F. Frankland, and Prof. R. Boyce.

† British Association Report, 1889.

‡ Presidential Address to the British Association for the Advancement of Science, delivered at Dover, on Wednesday, September 13, 1899.

made by some fellow-worker, in the years long gone by, comes away from that study humbled by one or other of two different thoughts. On the one hand he may find, when he has translated the language of the past into the phraseology of to-day, how near was his forerunner of old to the conception which he thought, with pride was all his own, not only so true but so new. On the other hand, if the ideas of the investigator of old, viewed in the light of modern knowledge, are found to be so wide of the mark as to seem absurd, the smile which begins to play upon the lips of the modern is checked by the thought Will the ideas which I am now putting forth, and which I think explain so clearly, so fully, the problem in hand, seem to some worker in the far future as wrong and as fantastic as do these of my forerunner to me? In either case his personal pride is checked. Further there is written clearly on each page of the history of science, in characters which cannot be overlooked, the lesson that no scientific truth is born anew, coming by itself and of itself. Each new truth is always the offspring of something which has gone before, becoming in turn the parent of something coming after. In this aspect the man of science is unlike, or seems to be unlike, the poet and the artist. The poet is born, not made; he rises up, no man knowing his beginnings; when he goes away, though men after him may sing his songs for centuries, he himself goes away wholly, having taken with him his mantle, for this he can give to none other. The man of science is not thus creative; he is created. His work, however, great it be, is not wholly his own; it is in part the outcome of the work of men who have gone before. Again and again a conception which has made a name great has come not so much by the man's own effort as out of the fulness of time. Again and again we may read in the words of some man of old the outlines of an idea which in later days has shone forth as a great acknowledged truth. From the mouth of the man of old the idea dropped barren, fruitless; the world was not ready for it, and heeded it not; the concomitant and abutting truths which could give it power to work were wanting. Coming back again in later days, the same idea found the world awaiting it; things were in travail preparing for it; and someone, seizing the right moment to put it forth again, leaped into fame. It is not so much the man of science who makes science, as some spirit which, born of the truths already won, drives the man of science onward and uses him to win new truths in turn.

It is because each man of science is not his own master, but one of many obedient servants of an impulse which was at work long before him, and will work long after him, that in science there is no falling back. In respect to other things there may be times of darkness and times of light, there may be risings, decadences, and revivals. In science there is only progress. The path may not be always a straight line, there may be swerving to this side and to that, ideas may seem to return again and again to the same point of the intellectual compass; but it will always be found that they have reached a higher level—they have moved, not in a circle, but in a spiral. Moreover, science is not fashioned as is a house, by putting brick to brick, that which is once put remaining as it was put to the end. The growth of science is that of a living being. As in the embryo phase follows phase, and each member of the body puts on in succession different appearances, though all the while the same member, so a scientific conception of one age seems to differ from that of a following age, though it is the same one in the process of being made; and as the dim outlines of the early embryo become, as the being grows more distinct and sharp, like a picture on a screen brought more and more into focus, so the dim gropings and searchings of the men of science of old are by repeated approximations wrought into the clear and exact conclusions of later times.

(To be continued.)

AMERICAN LOCOMOTIVES IN ENGLAND.

IN 1840 five locomotives were shipped from New York to England, and they were put to service on the Gloucester & Birmingham Railway. This now rather aged piece of history has been dug up by The Toronto Globe. In view of the signal triumphs of American locomotives in foreign lands the comments of our contemporary, apropos of the occurance of fifty-nine years ago and those of to-day, are of interest. Speaking of the shipment in 1840, the publication mentioned says: "This was, at that early day, a large shipment, and the event was no doubt regarded as the forerunner of other shipments of the same nature and the final destruction of engine building in Britain through American competition." Our contemporary evidently wishes to think that somewhat similar conditions exist to-day, for it adds reassuringly that "those who regard the destruction of Britain's iron industries by competition from the United States as a new danger may be relieved in mind by this scrap of history. American competition has been destroying British industry for about sixty years, and the work of demolition is further from completion now than it was in 1840." It may be well to add in connection with the foregoing that the undercurrents of a half a century have no bearing on the locomotive industry of to-day. It has long since evoluted from its swadding cloths, and the same is true of the industries essentially akin to that of locomotive building. Cheapness, facility, excellent workmanship, a bounteous supply of raw material and never-ceasing progressiveness are some of the elements that have brought this industry to its present enviable position. While passing it may be well to note that Consul Halstead, United States consul at Birmingham, is of the opinion that a strong feeling exists in England over the orders given for American locomotives. Consul Halstead warns American builders that an effort will be made to find the locomotives inferior to British-built engines.

M. Jouffroy d'Albans, the French Consul at Singapore, writes to the Courrier de Saigon regarding an invention made by a Frenchman in the Straits to extract gutta-percha, principally from the leaves of Isonandra Hookeria. The leaves, dried, are sent to Belgium and France for the extraction of the gutta. This trade in gutta-percha leaves has considerably increased at Singapore and Penang.

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